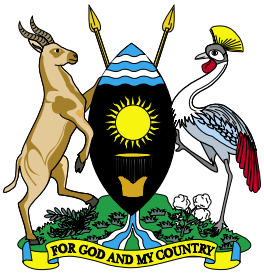
THE REPUBLIC OF UGANDA

THE ENVIRONMENTAL MONITORING PLAN FOR THE ALBERTINE GRABEN

2012-2017



THE REPUBLIC OF UGANDA

THE ENVIRONMENTAL MONITORING PLAN FOR THE ALBERTINE GRABEN

2012 - 2017

NEMA
National Environment Management Authority
ENSURING SUSTAINABLE DEVELOPMENT

ROYAL NORWEGIAN GOVERNMENT

NORWEGIAN DIRECTORATE
FOR NATURE MANAGEMENT

NFA
National Forestry Authority

*for a living planet**

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Oil exploration in the Albertine Graben

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LIST OF ACRONYMS

AEAM	-	Adaptive Environmental Assessment and Management
AG EMP	-	Albertine Graben Environmental Monitoring Plan
a.m.s.l	-	above mean sea level
BGBD	-	Below Ground Biodiversity
CAS	-	Catch Assessment Survey
CDP	-	Community Development Department
CSOs	-	Civil Society Organisations
DFR	-	Directorate of Fisheries Resources
DLG	-	Department of Local Government
DN	-	Norwegian Directorate for Nature Management
DOM	-	Department Of Meteorology
DOOH	-	Department of Occupational Health
DWRM	-	Directorate of Water Resources Management
EA	-	Exploration Area
EIA	-	Environmental Impact Assessment
EIN	-	Environment Information Network
EPT	-	Ephemeroptera -Plecoptera -Trichoptera
FAO	-	Food and Agriculture Organization of the United Nations
GIS	-	Geographic Information System
GPS	-	Global Positioning System
IEC	-	Information Education Communication
IH	-	Impact Hypotheses
IPP	-	Integrated Power Project
IUCN	-	International Union for Conservation of Nature
MAAIF	-	Ministry of Agriculture, Animal Industry and Fisheries
MCS	-	Monitoring Control and Surveillance
MEMD	-	Ministry of Energy and Mineral Development
MoGLSD	-	Ministry of Gender, Labour and Social Development
MIST	-	Management Information System Technology
MLHUD	-	Ministry of Lands, Housing and Urban Development
M&E	-	Monitoring and Evaluation
M&R	-	Monitoring & Research
MoES	-	Ministry of Education and Sports
MoH	-	Ministry of Health
MoTWC	-	Ministry of Transport, Works and Communication
MoU	-	Memorandum of Understanding
MTWH	-	Ministry of Tourism, Wildlife and Heritage
MUIENR	-	Makerere University Institute of Environment and Natural Resources
MWE	-	Ministry of Water and Environment
NaFIRRI	-	National Fisheries Resources Research Institute
NP	-	National Park
NARL	-	National Agricultural Research Laboratories
NEA	-	National Environment Act
NEMA	-	National Environment Management Authority
NFA	-	National Forestry Authority
NINA	-	Norwegian Institute for Nature Research
NGO	-	Non-Governmental Organization
OfD	-	Oil for Development
OSH	-	Occupational Safety and Health
PEPD	-	Petroleum Exploration and Production Department
PHCs	-	Polychlorinated Hydrocarbons
RBDC	-	Ranger Based Data Collection
RU	-	Reservation Unit
TWA	-	Time Weighted Average
UTM	-	Universal Transverse Mercator
UWA	-	Uganda Wildlife Authority
VECs	-	Valued Ecosystem Components
WHO	-	World Health Organization
WMD	-	Wetlands Management Department
WWF	-	World Wide Fund

FOREWORD

Dr. Tom O. Okurut

The Albertine Graben region in western Uganda is widely known for its richness in both flora and fauna, and over the last decade it has also received much attention for its deposits of oil and gas as well as the exploration of these resources. The oil and gas that are being rapidly explored engages many stakeholders and it is expected that when the extraction of these resources begins, it will have great economic impact on the country. Concurrently, it is also expected that developments in the region will have a lasting impact on the unique environment of the Albertine Graben. It is against this background that the National Environment Management Authority in partnership with other stakeholders from the Environmental Information Network has worked towards producing an Environmental Monitoring Plan for the Albertine Graben (AG EMP).

The AG EMP is intended as a guiding tool in tracking the impact which oil and gas-related developments will have on the environment of the Albertine Graben. As such, the monitoring plan lists a number of environmental monitoring indicators that will be used to monitor a defined list of five major Valued Ecosystem Components, including: aquatic, terrestrial, physical/chemical, society, and management & business. Over time, the monitoring indicators will demonstrate progress and changes in the ecosystem components, signaling when environmental management in the petroleum sector is on track, or giving early warnings for when developments are heading in the wrong direction.

Furthermore, the AG EMP gives a detailed summary of the current state of the environment in the Albertine Graben, the possible effects which oil and gas developments may have on species such as fish, mammals, amphibians and birds, and other environmental components including water and air quality. Major potential drivers of change identified in the report include noise and vibrations, waste disposal, seismic activities and an influx in traffic, people and subsequent urban expansions.

In face of the rapid changes in the Albertine Graben, protecting its environment is of urgent importance, and the National Environment Management Authority (NEMA) and partners feel pleased to publish this environmental monitoring plan.

We believe that this report will be used as a tool for monitoring any changes in the environment before, during and after the extraction of oil and gas in the Albertine Graben when used by all stakeholders, academicians and researchers. When used appropriately, it is hoped that the impact of the monitoring plan will be shown in terms of regular monitoring reports and subsequent early warnings of any negative changes in the environment.

Dr. Tom O. Okurut
EXECUTIVE DIRECTOR
NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

EXECUTIVE SUMMARY

This report provides a blueprint of an environmental monitoring plan that will ensure sustainable exploitation and utilization the petroleum resources discovered in the Albertine Graben. The report notes that oil and gas activities in this area, which is known for its high biodiversity richness and diversity, must not ignore the vast biological resources. It gives a number of selected parameters and indicators that should be used in monitoring environmental changes caused by oil and gas activities. The core message of this report is that oil and gas activities may have adverse environmental and social effects if not well managed. The report provides insight and early warning to policy makers and other stakeholders on environmental changes that may arise as a result of oil and gas activities.

The report is divided into eight chapters:

Chapter 1, ***Introduction and Background*** provides the scope and background information to the Albertine Graben.

Chapter 2, *Environmental Status of the Albertine Graben* gives an overview of the social and environmental conditions of the exploration areas. It summarizes the climatic conditions that prevail in the Graben and highlights the mineral deposits found in this area. The chapter then presents some of the core conservation concerns in the region, focusing on species richness and those classified as endangered or threatened. Lastly, the chapter looks at the sensitivity of biodiversity to oil and gas activities as well as the various plans and projects that Government seeks to put in place and implement in the area.

Chapter 3, *Selecting Valued Ecosystem Components, Indicators and Parameters,* focuses on the process used in identifying appropriate parameters and indicators to be used in monitoring environmental changes in the Albertine Graben. It discusses the scoping process used in identifying indicators for the environmental monitoring plan. The chapter also presents the criteria and approach used in adopting the final parameters and indicators.

Chapter 4, *Valued Ecosystem Components, Indicators and Parameters,* specifically looks at the process used to identify ecosystem components in the Albertine Graben for environmental monitoring. It provides detail of important valued ecosystem components (VECs) identified. These include the main thematic issues namely aquatic, terrestrial, physical/ chemical, society, management and business. The chapter highlights possible effects of oil and gas activities on the ecosystem components such as fish, mammals, birds, reptiles, amphibians, wetlands, soil, water and plants. Oil and gas activities have varied impacts on these components. Some of the impacts include water and air pollution, habitat destruction, illegal logging, encroachment and noise or vibrations that may disturb the breeding and migration patterns of wildlife. The chapter provides a summary of valued ecosystem components and the possible driving forces. Additionally, it looks at the parameters to be used, priority indicators, type of monitoring, the location, frequency and institutions responsible. It also discusses why monitoring is critical in management of resources and highlights the existing monitoring and available data.

Chapter 5, *Data Collection and Analysis* looks at all the valued ecosystem components identified and highlights the basis for monitoring. The chapter notes that Lake Albert has been internationally recognized as a biological hotspot because of its endemic fish species. Monitoring of fish resources is important, as there is risk of water pollution from oil and gas activities. Activities such as offshore seismic surveys and drilling generate noise and vibrations that may disturb fish distribution patterns. The chapter also highlights key drivers which may result in changes in animal distribution and behavior. It focuses on how infrastructure development will affect wildlife and wildlife habitats. The chapter further notes that hazardous waste may affect biodiversity especially through the food chain. It is also pointed out that poaching is likely to increase as a result of human influx.

Chapter 6, *Data Management Framework,* looks at approaches of creating a timely, publicly accessible, efficient and transparent information platform. This framework will be instrumental in enabling the plan to report on state of the environment on a regular basis. The framework provides for the need to deliver information and knowledge using effective and flexible reporting formats to facilitate decision making at various levels. The chapter discusses the Environment Information Network (EIN) decision to develop an environmental data clearing house housed at the National Environment Management Authority (NEMA).

Chapter 7, *Reporting* looks at the reporting associated with the Albertine Graben Environmental Monitoring Plan (AG EMP). The methods of reporting to be used will vary depending on the recipient or target audience. Regular reporting will be required for the Government and other stakeholders. The chapter also provides a summary of reporting formats, the frequency of reporting and information dissemination.

Chapter 8, *Implementation Framework of the Monitoring Programme* discusses the implementation of the monitoring programme. The chapter describes a simple and cost effective structure that ensures effective implementation, continuous data management, and regular review of the monitoring plan. The EIN will oversee and implement the monitoring programme. A programme review will be conducted every three years. Implementation schedule and budget are also discussed with the need for a sustained funding to monitor all components in the plan.

1 INTRODUCTION AND BACKGROUND

The Albertine Graben is situated in the Northern part of the left arm of the East African Rift valley. It has a tertiary basin of about 500km long, averaging 45km.19 percent of the Albertine Graben is covered by water bodies (rivers and lakes) and it is also rich in natural resources (minerals, petroleum, fauna and flora). This area has the largest number of protected areas in Uganda, including game reserves, Ramsar sites and a large number of endemic species.

1.1 OVERALL GOALS AND OBJECTIVES OF THE ALBERTINE GRABEN ENVIRONMENTAL MONITORING PLAN

Following the confirmation of availability of commercially viable Oil and Gas deposits in the Albertine Graben, it is necessary to upscale monitoring of the environmental changes within the region. Environmental Monitoring will be done using environmental indicators. Environmental indicators are information tools that summarize, simplify information and help in understanding the status and threats to environmental resources such as biodiversity. Therefore indicators are simple measures that tell us what is happening in the environment. They are a way of presenting and managing complex information in a simple and clear manner that can form the basis for future action and can be readily communicated to internal or external stakeholders as appropriate. This document outlines indicators that were discussed during the stakeholders' scoping workshop held in April 2011 (Thomassen & Hindrum 2011).

1.2 SCOPE OF THE ALBERTINE GRABEN ENVIRONMENTAL MONITORING PLAN

Oil and Gas activities may have severe and long term impacts on the environment if they are not managed well. A monitoring system will enable the regulators to easily understand, predict, minimize, prevent and/or mitigate adverse impacts. It will also help to provide insight into the state of the environment. An updated database on the performance of the environmental indicators will provide the first early warning signs and also a baseline for any remedial measures that may need to be undertaken.

The Giant Lobelia found in the Albertine Graben

2 THE ALBERTINE GRABEN

2.1 ENVIRONMENTAL STATUS OF THE ALBERTINE GRABEN

Physical Environment

The Albertine Graben is a Cenozoic rift basin formed and developed on the Precambrian orogenic belts of the African Craton. Rifting was initiated during the late Oligocene or Early Miocene (25-40 million years ago). The Albertine Graben has a sharp variation in rainfall amounts, mainly due to variations in the landscape (NEMA 2008). The landscape ranges from the low lying Rift Valley floor to the rift's escarpment, and the raised mountain ranges. The highest landscape is the mountain ranges of Rwenzori, where the Rwenzori mountains towers at over 5000m above mean sea level (a.m.s.l). The rift valley floor lies in a rain shadow of both the escarpment and mountains, and has the least amount of rainfall average of less than 875mm per annum which is much lower than that of the highland area. The maximum temperatures are above 30°C which can sometimes reach 38°C. Average minimum temperatures are relatively consistent and vary between 16°C and 18°C. Wind speed and direction records indicate a high incidence of strong winds especially in the rift valley. The prevailing winds commonly blow along the valley floor in the north-east to south-west direction or vice versa. Winds also blow across the rift valley in an east to west direction. Within the Albertine Graben, there are three main lakes: Lake Albert, Lake Edward and Lake George. Most of the rivers and streams originating from the highlands surrounding this area drain into the lakes which, in turn, drain into the River Nile via Lake Albert.

Mineral Resources

The economic mineral resources in the Albertine Graben include lime, dolomite, copper, cobalt, limestone deposits at Hima, and Gypsum in the Kibuku area near Sempaya in Semliki, Bundibugyo District. Gold has also been reported to exist in Maramagambo forest south of Lake Edward in Bushenyi District, while to the extreme south-west, deposits of iron-ore, gold and wolfram are known to exist especially in the escarpment region of Kabale, Kanungu and Rukungiri districts (NEMA, 2008).

Ecosystems and Biodiversity

A wide variety of vegetation ecosystems and species are known to exist in the region; on the mountain and escarpment slopes and in the valleys and flats. The main vegetation ecosystems include montane forests, tropical forests (including riverine and swamp forests), savannah woodlands and grassland mosaics, papyrus and grassland swamps.

The rich and varied flora of the region provides habitats for an equally wide diversity of animal communities and species. The grasslands have great potential to support a high biomass of wild animals, for example, the short and medium grassland savannah is preferred by animals like the Uganda Kob and bird species such as *Piaepiac* which feed on the ticks that are often

found on the antelopes. The Albertine region is very rich in bird species whose habitats range from forest and grassland to wetlands and deltas. The delta area on Lake Albert shores, for example, is a convergence zone for the River Nile and Lake Albert which flows through the shallow papyrus swamps. The swamps are well known for supporting a wide variety of water birds, including the Shoebill. The delta species are part of the 400 already known in the whole of Albert and Murchison Falls National Park area.

There is also a wealth of biodiversity outside the protected areas. Unfortunately, the bulk of this is either already disturbed or threatened, while some of it is already extinct. Conservation of this biodiversity requires land-use based incentives to land owners and users. Oil and gas exploration and development will certainly escalate the threats to this biodiversity.

Biodiversity

The Albertine rift is incredibly species rich. It also has a high number of endemic species. This is a result of the high diversity of habitats that are found here. These habitats include glaciers, alpine vegetation (including giant forms of plants that occur at lower altitudes such as giant *Lobelias* and *Senecios*), montane forest, lowland forest, savannah grasslands and woodlands, papyrus swamps, high altitude swamps, lava rock and the specialist vegetation that colonizes it, hot springs, and lakes which also have high numbers of species of fish. Although much survey work has been carried out on birds and large mammals, groups like reptiles and amphibians are still inadequately surveyed.

The Albertine rift is the most rich in vertebrate species on the African continent (NEMA 2008). The area has 14% of all African reptiles (175 species), 19% of Africa's amphibians (119 species), 35% of Africa's butterflies (1300 species), 52% of all African birds (1061 species), 39% of all African mammals (402 species), 14% of Africa's plants (5,800 species) and over 400 fish species. The reptile and amphibian groups have, however been poorly distributed in the rift but the numbers are expected to increase. Of these, 35 mammal species are considered highly threatened by extinction (Critically Endangered, Endangered or Vulnerable as classified by IUCN criteria), 25 birds species, 16 amphibian species and 40 plant species are considered highly threatened. So far 34 endemic mammals, many of which are small mammals, 41 birds, 16 reptiles, 34 amphibians and 117 butterfly endemic species have been identified in the region.

The Ugandan section of the Albertine region is no exception. It is one of the richest biodiversity areas in Uganda, and this is well reflected by the many protected areas located in this region. The mountain gorilla, the Rwenzori red duiker and the golden monkey are examples of regional endemic mammal species. In Bwindi Impenetrable forest and Kibale National Parks, scientists have recorded 173 species of polypore fungi, which is 16% of the total species known from North America, Tropical Africa and Europe. Additionally, the mountains and forests in this region are important watersheds for the supply of regular and clean water to both surrounding and distant communities.

2.2 LAND USE AND SOCIO-ECONOMIC STATUS

The Albertine Graben covers a total land area of 6,788,616 ha. Out of this, 5,369,164 ha (79.1%) is under agriculture, settlement and other land uses. The remaining 1,419,452 ha (20%) are protected areas. In the northern part of the Albertine Graben, the districts of Arua and Nebbi have the highest population densities while Amuru has the lowest. In the Albertine Graben region, the districts with the highest population densities are Kibaale and Masindi while Buliisa and Kiboga have the lowest. Further south, the district with the highest population density is Bushenyi while Kasese and Rukungiri have the lowest. The population structure in

the Albertine Graben reflects similar trends as those in the rest of the country.
The population has a pyramid structure reflecting a large dependent age. More than 50 percent of the population lies between 0-20 years of age. There are slightly more females than males representing 51% and 49% of the population, respectively.

The Albertine Graben is a centre of rapid urban growth. There are several upcoming urban centers in the Albertine Graben including Buliisa, Kasese, Masindi, Kanungu, Rukungiri, Hoima, Kagadi and Ntoroko. There is further growth of the old towns, with a large number of new town councils, town boards and municipalities coming up in the area. Oil exploration and development activities will most likely create further urbanization premises. This prospective growth needs proper planning to forestall unplanned urban sprawl, slum conditions and environmental degradation.

2.3 STATUS AND PROJECTION OF OIL AND GAS ACTIVITIES IN THE ALBERTINE GRABEN

The Albertine Graben is the most prolific area for petroleum exploration in Uganda. Uganda first discovered commercial quantities of hydrocarbons in the Albertine Graben in 2006. The Albertine Graben is subdivided into ten Exploration Areas (see map below). The Exploration Areas include EA 1 and 5 located to the north of Lake Albert, EA 2, 3A, 3B, 3C and 3D on and around Lake Albert, while EA 4A, 4B and 4C are located around lakes Edward and George in the southern part of the Graben. Five out of these ten Exploration Areas are licensed to oil exploration companies. About 2.5 billion barrels of oil have been discovered and which can last for over 20 years.

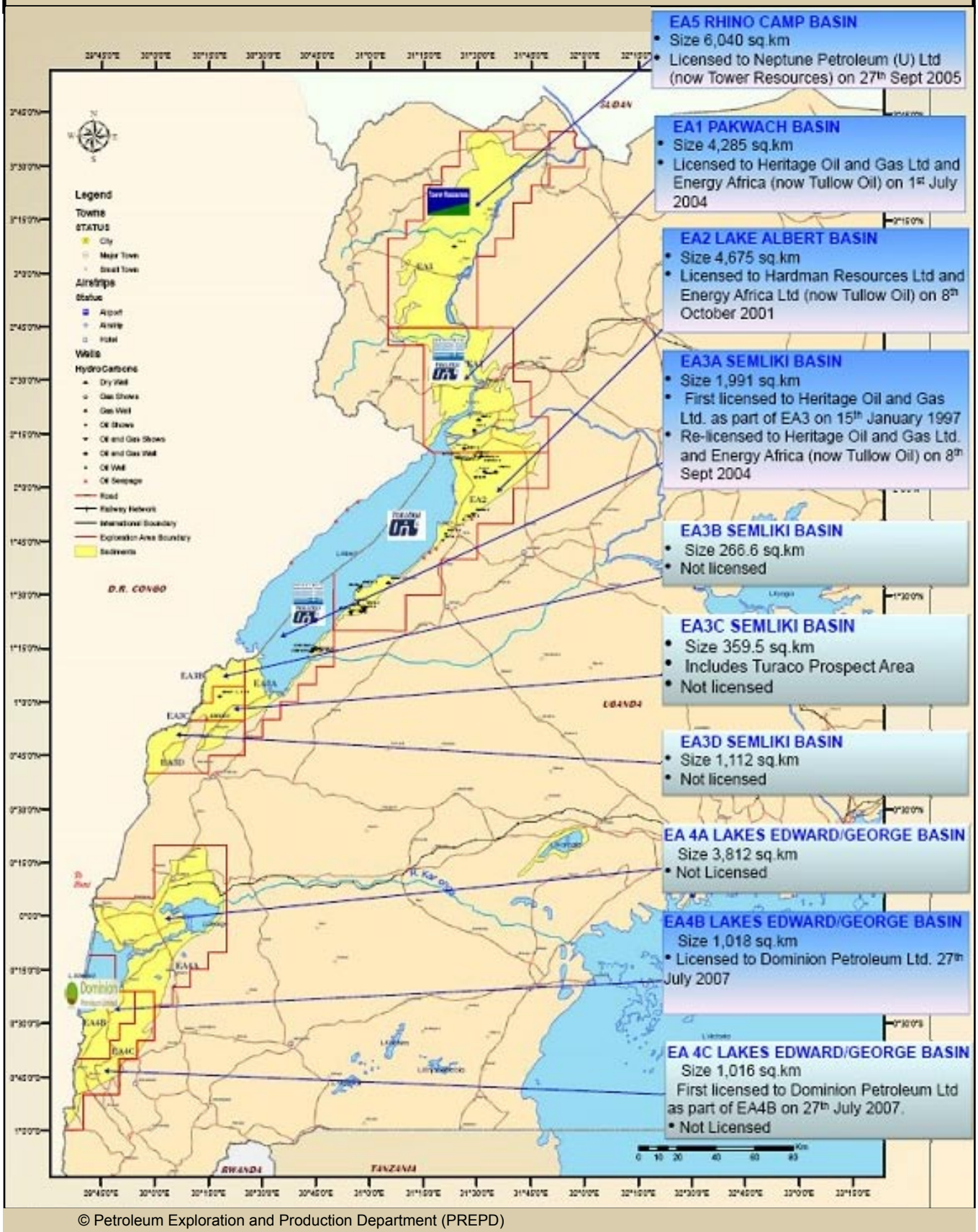
The Government is considering a basin wide development concept that will initially focus on the discoveries in EAs 1, 2 and 3A. Field development plans for Nzizi, Mputa, and Waraga are in final stages of review. Details of the implementation of the feasibility study for a refinery proposed at Kabaale in Hoima district undertaken by Foster Wheeler on behalf of Government are being considered.

An Integrated Power Project (IPP) has been proposed to utilize gas from the Nzizi field. The power project input will be supplemented by associated gas from neighboring fields, heavy fuel from extended well testing and later from an in-country refinery.

Wells will be connected to central processing facilities which will be linked to a central hub. Pipelines will be developed to link individual wells to processing facilities as well as processing facilities to the central hub and to the refinery.

Members of the Environment Information Network on a ground truthing mission to the Albertine Graben

STATUS OF LICENSING IN THE ALBERTINE GRABEN OF UGANDA



© Petroleum Exploration and Production Department (PREPD)

Figure 1: Status of Licensing in Albertine Graben
Source: PEPD 2011

2.4 EXPECTED INFRASTRUCTURAL DEVELOPMENTS

The proposed developments will require infrastructure in form of roads, pipelines, airstrips and railways. Plans are underway to tarmac the trunk roads that link the regions where oil discoveries have been made to Kabaale. Work on some roads such as the Hoima-Kaiso road is expected to begin this financial year (2011/2012). Production facilities will be linked to major road networks for access during routine maintenance and monitoring.

Development of the Albertine petroleum will require importation of heavy machinery into the country. Some of the crude could also be transported by railway if there is excess for locals that does not warrant the construction of pipeline.

Air transport is also proposed to be developed. The airstrip at Pakuba and Bugungu will be upgraded to accommodate the traffic as the production phase begins. Other airstrips/ airports are in plan with increase in petroleum developments for example an airport in the neighborhood of the proposed refinery.

The Ministry of Lands, Housing and Urban Development is in the process of formulating a physical development plans to avoid haphazard developments (such as slums, overcrowding and environmental degradation) in the Albertine Graben.

The various developments outlined above are potential sources of adverse environmental and social impacts. In order to minimize these impacts, it is necessary that biodiversity monitoring indicators are developed to track changes in the environment to ensure sustainable development.

Butiaba Oil Rig
Source: NEMA 2011

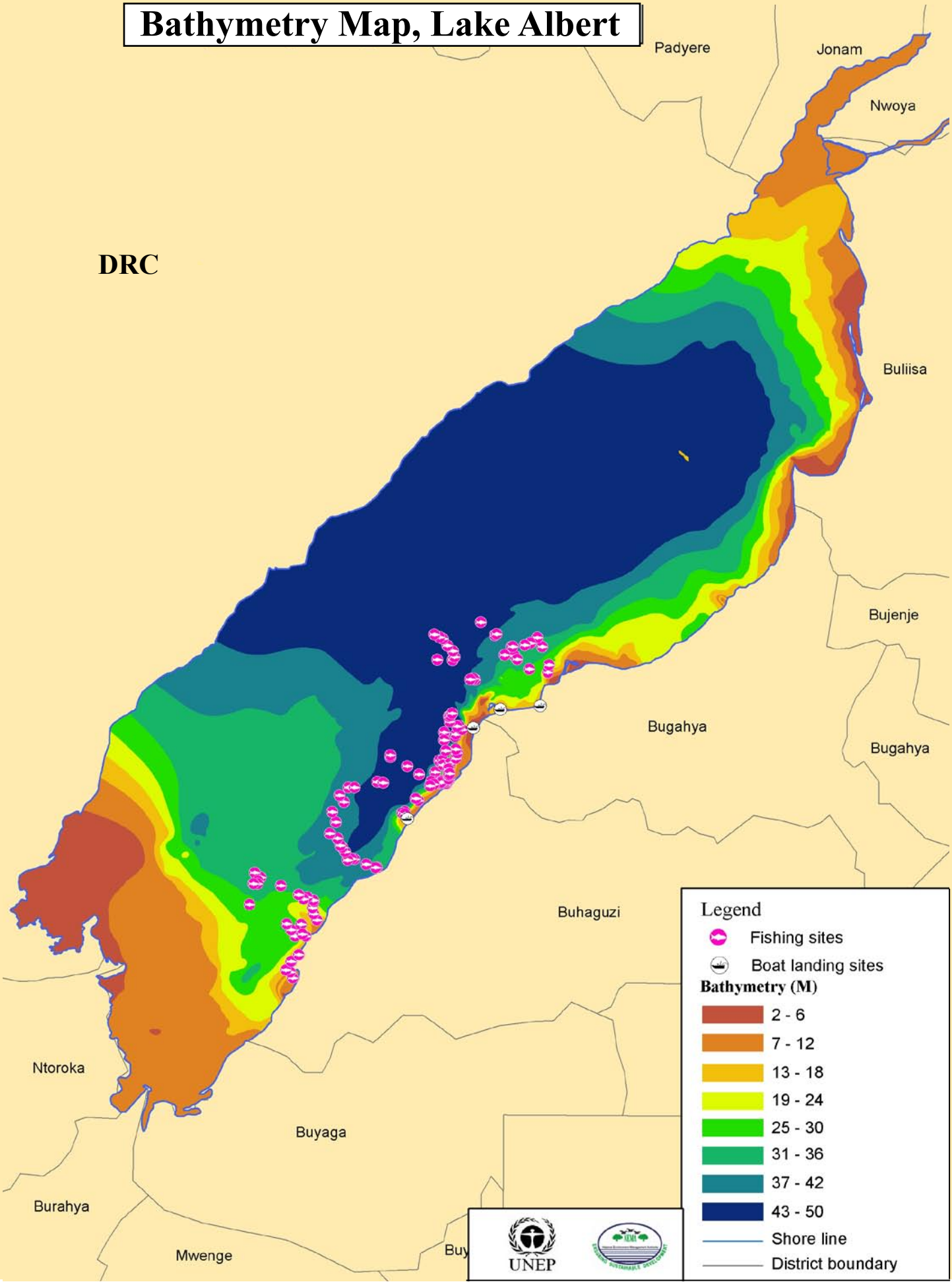


Figure 2: Bathymetry Map
Source: UNEP/NEMA 2010

3 SELECTING VALUED ECOSYSTEM COMPONENTS, INDICATORS, AND PARAMETERS

3.1 PROCESS FOR IDENTIFYING AND SELECTING COMPONENTS, INDICATORS, AND PARAMETERS

3.1.1 Background paper and workshop process

Most of the petroleum resources in Uganda are located within a region of high value biodiversity assets (unique wildlife and their habitats such as important rivers, lakes, forests, grasslands). While petroleum resources are finite and non-renewable; biodiversity assets are renewable and if managed well can continue to support economic development and human prosperity for a much longer period of time. It is therefore important that care is taken to ensure that exploitation of petroleum resources is done without compromising the quality and quantity of the environmental resources of the Albertine Graben.

Within this context, it has been found necessary to establish an environmental monitoring program with appropriate indicators. The National Environment Management Authority (NEMA) leads this process with funding and technical support from the Norwegian Government under the environment pillar of the Uganda Oil for Development (OfD) program.

3.1.2 Workshop process

NEMA with support from NORAD and the Norwegian Directorate for Nature Management (DN) has organized a number of workshops to develop an environmental monitoring programme for the Albertine Graben. The main objectives of these workshops were to identify focused and measurable indicators to be used in the environmental monitoring of impacts of petroleum activities in the Albertine Graben. The workshops adopted various participatory methods including focus group discussions, document review and interactive thematic presentations. These processes enabled the team to undertake scoping and final selection of the appropriate indicators to implement a monitoring programme.

3.1.3 Scoping process

According to Beanlands (1988) *"scoping refers to the process of identifying, from a broad range of potential problems, a number of priority issues to be addressed by an Environmental*

Impact Assessment (EIA)". Scoping with regards to the establishment of the environmental monitoring programme for the Albertine Graben in Uganda, refers to the process of identifying a limited number of issues to be addressed in the environmental monitoring programme with the aim to measure (indicators) the existing quality (baseline) and potential future changes of the environment and the society (ecosystem approach).

To ensure effective scoping developing environmental monitoring indicators for petroleum activities in the Albertine Graben, several initiatives have been undertaken, including the following;

i) A detailed study and understanding of the oil and gas development plans has been made with technical guidance from the Petroleum Exploration and Production Department (PEPD) which has provided an overview of existing activities and of future petroleum development plans; and

ii) A background paper for development of indicators for monitoring environmental changes in the Albertine Graben was developed and shared with the participants. This document provided an outline of suggested environment indicators that ought to be monitored to establish the status of the Albertine Graben environment resources in the presence of oil and gas exploration activities. The document was useful in placing the available environmental information about the Albertine Graben into context for a larger group of stakeholders to discuss and evaluate appropriate indicators.

The scoping process also established the status and access to available ecosystem baseline information for the Albertine Graben. Ecosystem baseline information refers to the background information on the environment and socio-economic setting for a proposed development project.

During the scoping, a limited number of indicators were identified. These included considerations of impact factors and potential impacts, decision makers, stakeholders, alternatives, access of baseline information, time schedule and economic frames. The scoping phase in an Monitoring and Evaluation (M&E) programme (as well as in a Strategic Environmental Assessment for the Albertine Graben and later in exploration area specific Environmental Impact Assessments) is furthermore critical for an optimal use of limited resources in the perspective of personnel, time and economy, and should be accomplished as early as possible in the process. The process of scoping and the criteria for selecting final parameters and indicators is elaborated below.

3.2 CRITERIA FOR SELECTING PARAMETERS AND INDICATORS

One major challenge in any monitoring and evaluation programme is to identify a limited number of indicators amidst a multitude of possible indicators. This was achieved through scoping (as described above), and included considerations of impact factors (drivers) and potential impacts, decision-makers, stakeholders, alternatives, access of baseline information, time schedule and economic frames among others. This scoping process was critical for the optimal use of limited resources in the perspective of personnel, time and funding.

The approach to selecting final indicators and parameters after scoping was the Adaptive Environmental Assessment and Management (AEAM) concept (Thomassen J. & Hindrum, R. 2011). As the proposed environmental monitoring process covers various subjects including; environment and natural resources as well as society, different actors and stakeholders were involved in different phases of the process. Obviously, communication between decision makers, authorities, management, Non-Governmental Organizations (NGOs), public,

consultants and scientists should be accomplished in a very early stage in the development of an M&E, with the objective to scope on important issues. AEAM is a participatory process, based on workshops attended by different stakeholder and project holders. Work was done in both plenary sessions and sub-groups.

In AEAM the impact predictions and significance includes:

1. The selection and prioritization of a limited number of Valued Ecosystem Components (VECs), which are focal issues potentially affected by the oil/gas development activities;
2. The identification of major drivers (impact factors from the oil/gas development);
3. Assessment of major linkages between the different VECs and the drivers by constructing cause-effect charts with linkage explanations;
4. Description of potential impacts through impact hypotheses and finally; and
5. Providing recommendations on further needs for research, investigations and management actions including M&E programme with indicators.

Key statements in every scientific work, as well as in an M&E programme, should be the transparency and possibilities to document and control the process and the choices done. It should be obvious that an open and well-documented process is essential when numerous subjects are rejected as not important enough.

The AEAM process adopted started with a description of the ecological and societal status of Uganda's Albertine Graben. This Graben has numerous species, species groups, habitats and processes which can be taken into account. There are also a number of anthropogenic and natural impact factors or drivers which can affect the ecosystem in one way or another. In a monitoring context, there is a challenge to select which parts of the ecosystem should be in focus and which drivers to be prioritized.

The systematic AEAM process focused on prioritized issues (VECs) and identified the most important pressures or drivers. A valued component will be the basis for selecting targeted monitoring indicators (clear and agreed indicators). Given a restricted number of VECs and drivers, cause-effect charts were subsequently constructed to put the VECs and the drivers in the context they belonged. Following the cause-effect charts, impact hypotheses were formulated. The impact hypotheses were explained and described in scientific terms and formed the basis for recommendations concerning research, investigations, monitoring and management/mitigation measures.

The following four evaluation categories were adopted for each identified impact hypothesis:

A. The hypothesis is assumed not to be valid;
B. The hypothesis is valid and already verified. Research to validate or invalidate the hypothesis is not required. Surveys, monitoring, and/or management measures can possibly be recommended;
C. The hypothesis is assumed to be valid. Research, monitoring or surveys are recommended to validate or invalidate the hypothesis. Mitigating measures can be recommended if the hypothesis is proved to be valid; and
D. The hypothesis may be valid, but is not worth testing for professional, logistic, economic or ethical reasons, or because it is assumed to be of minor environmental influence only or of insignificant value for decision making.

Environmental Monitoring Indicators

Environmental Monitoring Indicators are used for reporting potential changes in the ecosystem as a consequence of the oil and gas development, and provide the basis for decisions on mitigating measures or other management actions.

These monitoring indicators will demonstrate progress when environmental management in the petroleum sector is on track and provide early warning signals when such management is heading in the wrong direction.

It is important to determine the purpose and end users of each monitoring indicator, since successful indicators are used to support policy and decision-making. SMART indicators (see Box 1) can provide information on several issues (EEA 2005 and Background Paper NEMA 2011). Selected indicators should meet the following basic criteria:

1. **Policy relevance** in accordance with environment and development policy and objectives in Uganda;
2. **Available and routinely collected data secured regularly** to update the indicator data should be simple, but accurate to measure and cover both lower and higher tropic levels;
3. **Spatial and temporal coverage of data**: secure that the defined monitoring area will be covered over time and that the indicators are sensitive to ecosystem change caused by natural and anthropogenic drivers. These indicators should be linked to a "cause-effect";
4. **Existing monitoring data series should be continued**: good long term qualitative data series are essential in measuring trends and the value of such datasets only increases over time;
5. **Representativeness**: secure that most aspects of the ecosystem are covered, both physical aspects, biological components and the society, cover common species of public concern (e.g. red listed species) are of importance to local communities;
6. **Methodologically well founded**: through a clear description of the methodology to be used when measuring the indicators;
7. **Understandability**: secure that the indicators are clearly defined and understood by the stake-holders and end users (i.e. local community, decision makers, global public);
8. **Agreed indicators**: indicators mutually accepted by the stakeholders and end users;
9. Indicators should therefore cover common species as well as those of public concern (e.g. red listed species) are of importance to local communities; and
10. Indicators should be relatively simple to measure, allowing for repeatable, accurate measurements.

Box 1: SMART Indicators

Indicators should, to the extent possible, be SMART:

Specific - It should be exact, distinct and clearly stated;

Measurable - It should be measurable in some way, involving qualitative and/or quantitative characteristics;

Achievable - It should be realistic with the human and financial resources available;

Relevant - Does it measure the result?;

and

Time-bound - It should be achieved in a stated time-frame.

Members of the Environment Information Network visiting the proposed site for the Oil refinery.
Source: NEMA 2011

Species Richness

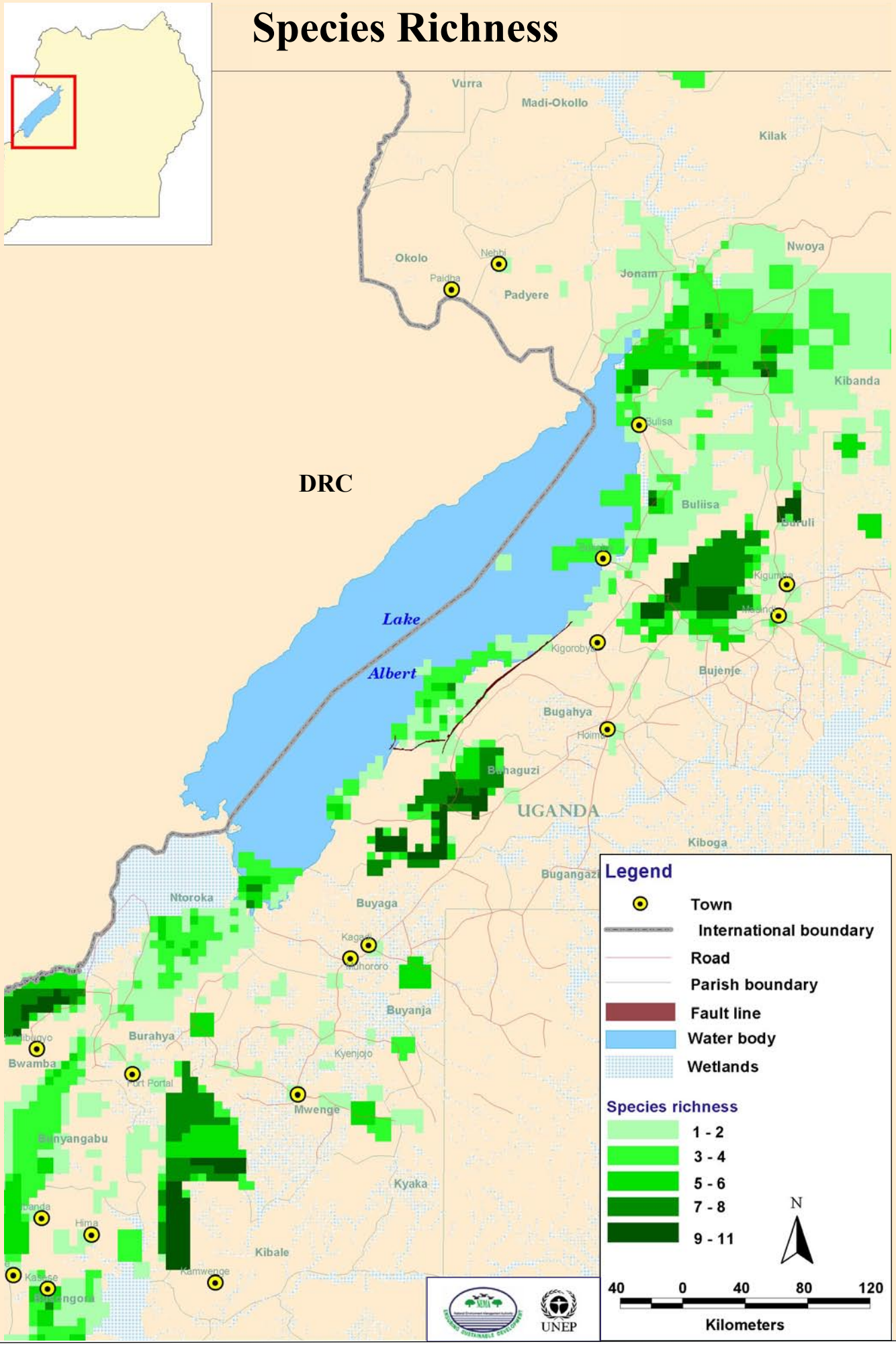


Figure 3: Species Richness
Source: UNEP/NEMA 2010

4 VALUED ECOSYSTEM COMPONENTS, INDICATORS, AND PARAMETERS

4.1 MONITORING OBJECTIVES

Resource monitoring is becoming an increasingly important subject. Increasing demand for resources, greater public involvement in management, issues of species population viability and ecosystem have all contributed to a need for a better understanding of resource, and how it changes over time. In order to assure the public that the management practices have acceptable effects on the ecosystems involved, monitoring is necessary. This helps to ensure that the actual results are within the expected range of effects. If not, then adaptive management decisions can be made to improve the situation.

Monitoring is the measurement through time that indicates the movement toward the objective or away from it. Monitoring will provide information about the status and trends of resources or ecosystems, but it should not be used to determine cause and effect. Monitoring is thus a means of checking on progress as well as a tool for improvement. Without it, there is no way of knowing if our management actions are working and how they should be changed to be more effective.

Monitoring has the objective of creating data which are to be compared to an explicit standard. Monitoring objectives should be clearly defined. It is common that limited funds are spent on monitoring efforts with few meaningful results. Carefully defining objectives, and then carefully matching methods to meet them, can mean the difference between an effective monitoring program and a waste of time and money one.

Main objectives of Monitoring are to:

- Provide information to users on the service level they can expect;
- Provide data for an objective evaluation of services and activities;
- Provide data to identify problems in the supply chain;
- Provide data to determine what measures are needed for improving services;
- Provide data to understand the need to increase or decrease resources; and
- Provide data to define parameters for the periodic review system calculations.

4.2 VALUED ECOSYSTEM COMPONENTS

The selection of Valued Ecosystem Components (VEC) for Environmental monitoring in the Albertine Graben was based on issues of physical, biological, social and cultural characters. These were discussed in two workshops including a scoping workshop, which was held in Kasese, and a finalization workshop in Mukono town. The following steps guided this process:

1. Identification and prioritization of Valued Ecosystem Components;
2. Identification and prioritization of drivers;
3. Construction of cause – effect charts; and
4. Assessing and filling in the Indicator Fact Sheets, i.e. impact hypotheses and recommendations.

Step 1. Valued Ecosystem Components

A Valued Ecosystem Component is defined as a resource or environmental feature that: is important (not only economically) to a local human population, or has a national or international profile, or if altered from its existing status, will be important for the evaluation of environmental impacts of industrial developments, and the focusing of administrative efforts (Hansson et al.1990).

Step 2. Drivers

Drivers are impact factors or driving forces which can affect the ecosystem and/or the society in one way or another. Based on the activity description of the proposed oil/gas development in the Albertine Graben, a number of drivers (or impact factors) can be identified.

Step 3. Cause - effect charts: Linking Valued Ecosystem Components and Drivers

A Cause – effect chart is a diagram of boxes and arrows indicating in which context each of the VECs appears, that is, which type of driver from the proposed activity can affect the VEC and how.

Each linkage was explained in a brief text following the chart. Hansson et al. (1990) described the content of the flow chart to include the main categories of the physical, biological and possibly also social and political factors influencing the VEC.

Step 4 and 5. Impact Hypotheses and Recommendations

An Impact Hypothesis is a hypothesis for testing the possible impact from the activity on the VEC. The impact hypothesis is based on the schematic flow chart and shall be explained and described preferably in scientific terms.

4.3 SUMMARY OF IDENTIFIED PRIORITY VECS

The five major thematic issues, at the Kasese workshop are summarized below.

1. Aquatic ecological issues
2. Terrestrial ecological issues
3. Physical/chemical issues
4. Society issues
5. Management and business issues

The western arm of the East African Rift System is one of the most important locations for the conservation of mammals, birds, and freshwater fish in Africa. The region is home to many

plant and animal species that are endemic to the region. These include the mountain gorilla, mountain monkey, golden monkey and 41 species of birds as well as many reptiles, amphibians and fish.

The wildlife areas are also a habitat to lions, leopards, bohor reedbuck, the giant forest hog and warthog, hippopotamus, giraffes, elephants, waterbuck, the African jackal and several other animal species. Open waters provide a unique ecosystem for animal life. Mammals such as hippopotamus, crocodiles and Sitatunga commonly occur in the estuarine and delta swamps, and other wetlands flanking open waters. In particular, crocodiles inhabit the shores of Lake Albert and River Wasa (Wango area). The Albertine region is very rich in bird species whose habitats range from forest and grassland to wetlands and deltas.

4.4 EFFECTS OF OIL DEVELOPMENT ACTIVITIES ON THE ECOSYSTEM

Fish

The Sensitivity of fisheries resources to petroleum development is associated with high frequency noise from petroleum development activities, oil spills and pollution from hydrocarbon compounds and chemicals from mud cuttings. These can cause drastic change in aquatic environment leading to migration or death of fish.

Fishermen on Lake Albert.
Source: NEMA 2011

Kaiso Tonya Fishing village and the silver fish (*mukene*) found in L. Albert.
Source: NEMA 2011

Mammals

From seismic survey, mammals and crocodiles are sensitive to vibrations, movement of heavy equipments and the drilling activity. The noise resulting from petroleum activities interfere with breeding patterns of wildlife. The clearing of vegetation during various infrastructure developments reduces the habitats for wildlife, destroys the homes of some animals and may block the corridors for animals. The oil spills and pollution from other chemicals used during petroleum developments may contaminate water sources for wildlife and may affect the water dwelling animals e.g. birds and fish species.

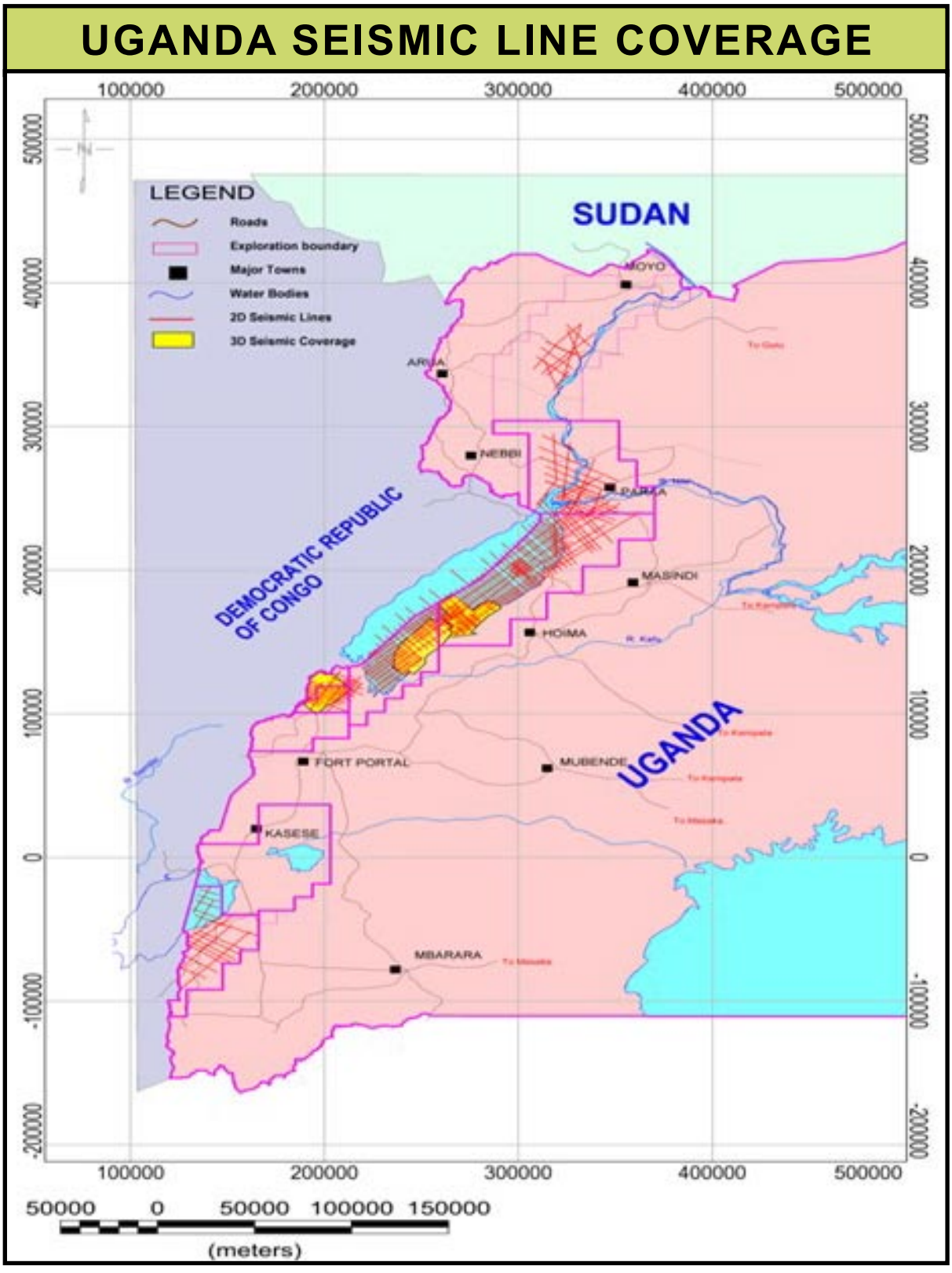


Figure 4: Uganda Seismic Line Coverage
Source: PEPD 2011

A Seismic line.
Source: PEPD 2011

Hippos in the River Nile.
Source: NEMA 2011

Buffalos in Murchison Falls National Park.
Source: NEMA 2011

Elephants in the Murchison Falls National Park
Source: NEMA 2011

Cattle in Buliisa District.
Source: NEMA 2011

Birds

Birds are affected by habitat destruction, air pollution and waste water from oil and gas activities.

Grey-headed Kingfisher (*Halcyon leucocephala*).
Source: NEMA 2011

Piacpiac (*Ptilostomus afer*)
Source: NEMA 2011

Red-checked Cordon-Blue (*Uraeginthus bengalus*).
Source: UWA

Spur-winged Plover (*Vanellus spinosus*).
Source: UWA

Plants

Plants are affected through clearing of the development site, oil spills and pollution. For plant species, the issues to consider are how fast an area would recover from disturbance if cleared and which vegetation types are likely to be most affected if an oil spill occurred. There are species that have a limited distribution range. For species that take very long to recover and those that have a limited distribution range, the areas where they occur will need to be avoided or used with extreme care.

The Crested Crane, Uganda's National symbol found in the Albertine Graben.
Source: NEMA 2011

Kabwoya landscape.
Source: NEMA 2011

Kaiso Tonya - Hoima Landscape.
Source: NEMA 2011

Ntoroko Biodiversity.
Source: NEMA 2011

Forest cover

Some of the threats to the forests are; encroachment for cultivation, illegal logging and grazing, fuel wood and poles extraction.

Maramagambo Central Forest Reserve.
Source: NEMA 2011

Wetlands

Wetland sensitivity is related to difficulty of restoration if affected by oil spills. This would affect breeding areas and habitats of birds, fish, amphibians and some mammals. It also affects the ground water recharge. Papyrus and swamp forest wetlands are the most sensitive.

Features of a wetland.
Source: NEMA 2010

Lake George Ramsar site.
Source: NEMA 2011

Water Quality

Surface water sources within the Graben are very vulnerable to contamination and are therefore categorized as highly sensitive. Sensitivity reduces with distance from the respective sources. For surface water, the sensitivity of each of these sources is highest at the source and reduces away from the source. For ground water, the shallower the groundwater first strike point the more susceptible it is to contamination.

Physical Chemical Issues

Potential of soil, air and water contamination with oil is great in oil activity. Oil pollutants in soil may be in form of spent solvents and metal finishing solutions. It has potential to cause spontaneous soil chemical changes.

The sensitivity of the shoreline and shallow waters was based on breeding areas for fish and wildlife, fish landing sites, and watering points for wildlife. The southern part of Lake Albert and the area around Kabwoya Wildlife Reserve had the highest sensitivity.

4.5 DRIVERS

There were a numbers of drivers that came up during the scoping exercise and then prioritized.

Table 4.1 Summary of VECs and Drivers Identified

Main thematic issue	VECs	Drivers
Aquatic ecological issues	7	6
Terrestric ecological issues	13	23
Physical/chemical issues	5	25
Society issues	11	12
Management and business issues	6	12
TOTAL	**42**	**78**

Table 4.2 Identified Drivers

Group No:	1	Issue	Aquatic ecosystem			
Overall Rank	Drivers\phase → ↓	Exploration	Drilling	Production	Decommissioning	Others
1	Waste disposal	2	3	3	3	
2	Oil spill	1	2	3	1	
3	Physical presence	3	3	2	2	
4	Noise/vibrations	3	3	2	1	
5	Access/foot print	2	2	3	1	
6	Water abstraction	1	1	3	1	
Group No:	**2**	**Issue**	**Terrestrial ecosystem**			
Overall Rank	**Drivers\phase → ↓**	**Exploration**	**Development**	**Production**	**Decommissioning**	**Others**
	Seismic activities	3	2			
	Camps	3	3	3	1	
	Blasts	3	2			
	Roads	3	3	3		
	Pipelines		2	3		
	Drill sites	3	3	2		
	Vehicle traffic	3	3	3	2	
	Human influx	3	3	2	1	
	Poaching	3	3	2	1	
	Spills	1	1	3	1	
	Hazardous waste	3	1	3	1	
	Domestic waste	3	3	3	1	
	Flaring	3		3		
	Lighting at facilities	3	1	2	1	
	Refinery plant		2	3	3	
	Burrow pits	3	3	2	1	
	Power plant		2	3		
	Oil storage facilities	1	1	3	1	
	Airstrips/pads	2	3	3	1	
	Jetty sites	3	2	2		
	Explosives magazines	3	2			
	Re-injection	2	3			
	Illegal activities					
	Power lines					

Group No:	3	Issue	Physical and Chemical issues			
Overall Rank	Drivers\phase → ↓	Exploration	Drilling	Production	Decommissioning	Others
9	Waste Discharge	2	3	3	1	
7	Sediment Pollution	1	2	3	1	
6	Waste generation	1	2	3	1	
6	Pollution by Seepage into aquifer	1	3	1	1	
5	Aquifer mining	1	1	2	1	
4	Precipitation	1	1	1	1	
5	Evaporation	1	1	2	1	
6	Large Water abstraction	1	1	3	1	
6	Groundwater Recharge	1	1	3	1	
7	Air chemical pollutants	1	2	3	1	
7	Air Particulate pollutants	1	2	3	1	
5	Air Temperature	1	1	2	1	
11	Noise	2	3	3	3	
8	Soil Chemical pollution	1	3	3	1	
6	Soil productivity	1	1	3	1	
7	Soil erosion	1	2	3	1	
7	Soil permeability	1	2	3	1	
5	Soil temperature	1	1	2	1	
6	Changes in Soil Biota	1	1	3	1	
4	Changes in Rainfall amount and distribution	1	1	1	1	
5	Change in Wind Speed and Direction	1	1	2	1	
5	Change in Mean Temperature	1	1	2	1	
5	Change in Humidity	1	1	2	1	
6	Landscape degradation and distortions through land use practices	1	1	3	1	
7	Vibrations in ground structures	3	2	1	1	

Comments: 1,2,3 (increasing importance from 1 to 3)

Group No:	4	Issue	Society			
Overall Rank	Drivers\phase → ↓	Exploration	Drilling	Production	Decommissioning	Others
	Consumption (Food)	1	1	3	2	
	Economic development		1	3	1	
	Education	1	1	1	1	
	Infrastructure development	1	3	2	1	
	Labour	1	3	3	1	
	Migration	1	1	2	2	
	Mineral development	1	1	3	3	
	Pollution	1	2	3		
	Population	1	1	1	1	
	Production (Food)	1	2	3	1	
	Settlements	1	1	3	1	
	Storage (Food)			1	1	

Group No:	5	Issue	Business and Management			
Overall Rank	Drivers\phase → ↓	Exploration	Drilling	Production	Decommissioning	Others
	Land take/Clearance, Infrastructure					
	Visual Intrusion					
	Aquatic Disturbances					
	Oil Spills and Blow outs					
	Shifts in Economic activities					
	Traffic volume					
	Shifts in Economic activities					
	Settlements and Infrastructural development					

Table 4.3 Priority VECs and Combined Drivers

Category	Driver	
AQUATIC	Wetlands	Waste disposal
		Oil spill
		Water abstraction
		Physical presence Noise/vibrations
		Access/foot print
	Fish	Waste disposal
		Oil spill
		Noise/vibrations
		Water abstraction
		Access/foot print
TERRESTIAL	Flagship mammals (e.g. elephants, lions, Uganda Kob etc)	Infrastructure
		Hazardous waste
		Poaching
		Human influx
		Vehicle Traffic
	Flagship birds (e.g. African fish eagle, vultures, forest birds etc)	Infrastructure (plus Refinery and power plants)
		Hazardous waste and Oil spills
		Domestic Waste
	Flagship floral ecosystem components (e.g. wetlands, forests, savannas, woodlands, agriculture)	Infrastructure
		Hazardous Waste, Domestic Waste and Oil Spills
		Human Influx
	Below ground biodiversity (macro and micro organisms etc)	Infrastructure and human influx
		Hazardous Waste, Domestic Waste and Oil Spills
PHYSICIAL / CHEMICAL	Water	Drilling
		Water Abstraction
		Waste
	Air	Seismic tests, Vehicles, machinery and construction, Well tests
	Soil	Oil Spills, Waste Disposal
		Vegetation Clearance
	Micro Climate	Land use/cover change
SOCITEY	Settlements	Migration
		Labour
	Food	Food production and Storage
		Production
	Water and Sanitation	Population
	Health	Population
		Occupational hazards
	Energy	Population
		Industry
	Infrastructure	Mineral Development
	Education	Population
	Culture	Migration
	Archaeological and Cultural Sites	Infrastructure Development
BUSINESS AND MANAGEMENT	Tourism	Land take/Clearance, Infrastructure
		Visual Intrusion
	Fisheries	Aquatic Disturbances
		Oil Spills and Blow outs
	Agriculture	Shifts in Economic activities
	Transport	Traffic volume
	Forestry	Settlements and Infrastructural development
	Construction Materials	Settlements and Infrastructural development

4.6 PRIORITY INDICATORS AND PARAMETERS

Indicators and parameters by issue (biological, physical/chemical, society, management and business

There are no universal indicators cutting across the biological, physical/chemical, society and management issues. The priority indicators are based on issues, VECs and drivers as detailed in the Table 4.4 (on page 43).

Flaring in using the ever green burner at Mputa-3, 2008 (*left);* Blow outs *(right)*
Source: PEPD

Contained drilling waste.
Source: PEPD 2011

Table 4.4: Valued Ecosystem Components Drivers

ISSUES	VECS	Driver	Parameter to be monitored	Priority indicators /parameters	Type of monitoring	Monitoring location	Frequency	Responsible institutions
1. AQUATIC ECOSYSTEM								
	Wetlands	Waste disposal	Key water quality indicators (DO,P,N pH etc), Shannon-Weaver diversity index (Plant and animal species richness & composition), conductivity, Temperature, BoD, TSS, water level, Heavy metals, vegetation cover	(DO,P,N pH etc,) conductivity, Temperature, BOD, TSS, Lead, Zinc, Chromium, cover type, plant and animal diversity and composition, acreage	Environmental/ Biological	Wetland sites	Quarterly	WMD, NaFIRRI, DWRM/DFR
		Oil spill	Heavy metals,	Lead, Zinc, Chromium				
		Water abstraction	Water Level	Water level, Water table				
		Physical presence Noise/vibrations	Vegetation cover, Flow, Key water quality indicators (DO, P,N pH etc), Plant species richness & composition, water levels	DO,P,N pH conductivity, Temperature, BOD, TSS, Lead, Zinc, Chromium, cover type, plant and animal diversity and composition, cover type, water table, Acreage	Environmental/ Biological	Wetland sites	Quarterly	WMD, NaFFIRI, DWRM, NEMA, DFR
		Access/foot print	Key water quality indicators (DO, P,N pH etc), Shannon-Weaver diversity index (Plant and animal species richness & composition), conductivity, Temperature, BoD, TSS, water level, Heavy metals, vegetation cover	(DO,P,N pH etc,) conductivity, Temperature, BOD, TSS, Lead, Zinc, Chromium, cover type, plant and animal diversity and composition, acreage	Environmental/ Biological	Wetland sites	Quarterly	WMD, NaFIRRI, DWRM/DFR
	Fish	1. Waste disposal	Population structure, density, productivity, size at first maturity, condition factor, fecundity, Shannon-Weaver diversity Index, keystone fish species	Water quality (DO,P,N, Chl-a, BOD, COD, pH, PHCs, Transparency, conductivity), E.coli, Salmonella, Heavy metals	Biological	Different habitants	Quarterly	NaFIRRI/DFR
		2. Oil spill	Water quality (DO,P,N, Chl-a, BOD, COD, pH, PHCs, Transparency, conductivity), E.coli, Salmonella, Heavy metals	PHCs, BOD, COD, DO	CAS, Environmental assessment	Different habitants	Quarterly	NaFIRRI/DFR
		Noise/vibrations		Vibration frequency, Duration, Noise levels, Catch rates	CAS		Quarterly	NaFIRRI/DFR
		Water abstraction	Water Level	Water Levels	Environmental/ Biological	Major habitats near	Quarterly	DWRM/DFR

Table 4.4: Valued Ecosystem Components Drivers (*contd*)

ISSUES	VECS	Driver	Parameter to be monitored	Priority indicators /parameters	Type of monitoring	Monitoring location	Frequency	Responsible institutions
1. AQUATIC ECOSYSTEM								
	Fish					abstraction water points		
		Access/foot print	Population structure, density, productivity, size at first maturity, condition factor, fecundity, Shannon-Weaver diversity Index	Water quality (DO,P,N, Chl-a, BOD, COD, pH, PHCs, Transparency, conductivity), E.coli, Salmonella, Heavy metals	Environmental/ Biological	Areas close to foot print	Quarterly	NaFIRRI/DFR
2. TERRESTRIAL ECOSYSTEM	**Flagship mammals (e.g. elephants, lions, Uganda Kobetc)**	Infrastructure	Mammal numbers and diversity, mammal ranges (area), infrastructure density, gene diversity, stress hormone levels	Mammal numbers and diversity, mammal ranges (area), infrastructure density, traffic volumes, Animal injuries and kills	Ground counts		Annually	UWA, WCS, WWF
		Hazardous waste	Number of spill incidences, heavy metal levels in the food chain, presence and level of heavy metals in water and soils	Number of spill incidences, heavy metal levels in the food chain, presence and level of heavy metals in water and soils	Ground counts		Annually	UWA, PEPD
		Poaching	Number and location of snares, poached animals, apprehended poachers, number of public awareness & educationmeetings	Number and location of snares, poached animals, apprehended poachers, number of public awareness and education meetings	Patrols range based data reported		Daily	UWA
		Human influx	Human and animal demography (population, density, distribution, sex, age), number of human-wildlife conflicts reported	Human and animal demography (population, density, distribution, sex, age), number of human-wildlife conflicts reported, Incidences of human and animal injuries or death, crop raids and animal poisoning			Annually	UWA, DLG
		Vehicle traffic	Number of animal kills or injuries, vehicle count, stress hormone levels	Number of animal kills or injuries, vehicle count, stress hormone levels			Annually	UWA, Oil companies
	Flagship birds (e.g. African fish eagle, vultures, forest birds etc)	Infrastructure (plus Refinery and power plants)	Birds numbers and diversity, ranges (area), infrastructure density, gene diversity, stress hormone levels, Noise levels, light intensity, migratory patterns	Birds numbers, diversity and range			Annually	UWA, Nature Uganda, MUIENR
		Hazardous waste and Oil spills	Number of spill incidences, heavy metal levels in the food chain, presence and level of heavy metals in water and soils	Number of spill incidences, Bird kills, Air quality, presence and level of heavy metals in water and soils, Incidences of fire			Annually	UWA, PEPD, NARL, DWRM, MUIENR

Table 4.4: Valued Ecosystem Components Drivers (*contd*)

ISSUES	VECS	Driver	Parameter to be monitored	Priority indicators /parameters	Type of monitoring	Monitoring location	Frequency	Responsible institutions
2. TERRESTRIAL ECOSYSTEM								
		Domestic Waste	Birds demography (population, diversity, density, distribution, sex, age), disease among birds communities	Population, diversity, density, disease among birds communities				
	Flagship floral ecosystem compone-nts (e.g. wetlands, forests, savannas, woodlands, agriculture)	Infrastructure	Number and coverage of invasive species, areas that have changed from one cover type to another, number of conflicts reported	Land take, Area of Habitat destruction, Number and coverage of invasive species, areas that have changed from one cover type to another, Incidences of crop raids, human injuries				UWA, NFA
		Hazardous Waste, Domestic Waste and Oil Spills	Number and quantity of spills, spatial coverage of spill, response time to spills	Number and quantity of spills, spatial coverage of spill, Quantity of waste, Type of waste				PEPD
		Human Influx	Area of land cover types, biomass stocking including regeneration, biodiversity, trade in timber and non-timber products	Area of land cover types, biomass stocking including regeneration, biodiversity, trade in timber and non-timber products				NFA, PEPD
	Below ground biodiver-sity (macro and micro organisms, etc)	Infrastructure and human influx	Counts of soil BGBD e.g. earth worm and beetles	Counts of soil BGBD e.g. earth worm and beetles				NARL, Faculty of Agriculture Makerere University
		Hazardous Waste, Domestic Waste and Oil Spills	Counts of soil BGBD at representative waste disposal or oil spill sites	Counts of soil BGBD at representative waste disposal or oil spill sites				NARL,Faculty of Agriculture Makerere University
3. PHYSICAL / CHEMICAL								
	Water	Drilling	DO,P,N, Chl-a, BOD, COD, pH, PHCs, Transparency, conductivity, hardness, chloride, Nitrates, etc	DO,P,N, Chl-a, BOD, COD, pH, PHCs, Transparency, conductivity, hardness, chloride, Nitrates, etc	Laboratory analysis		Monthly (Surface water)	DWRM, DWD
		Water Abstraction	River discharge, lake levels, groundwater levels and rainfall	River discharge, lake levels, groundwater levels and rainfall			Daily (monthly) levels discharge measure-ments	DWRM

Table 4.4: Valued Ecosystem Components Drivers (*contd*)

ISSUES	VECS	Driver	Parameter to be monitored	Priority indicators /parameters	Type of monitoring	Monitoring location	Frequency	Responsible institutions
3. PHYSICAL / CHEMICAL								
	Water	Waste	Waste water, biological indicators, leachate parameters, heavy metals, PHCs and nutrient loads	Waste water, biological indicators, leachate parameters, heavy metals, PHCs and nutrient loads	Laboratory analysis		Monthly for ground water and surface water	DWRM
	Air	Seismic tests, Vehicles, machinery and construction, Well tests	Noise levels, vibrations, concentrates of gases (CO_2 , SO_2, NO_2) and particulate matter	Noise levels, vibrations, concentrates of gases (CO_2 , SO_2, NO_2) and particulate matter	Air Sampling		Monthly	PEPD, NEMA
	Soil	Oil Spills, Waste Disposal	Area covered by the spill. Magnitude and extent of oil traces, hydrocarbons, heavy metals, major and trace elements, ma, porosity, friability, erosibility, composition, soils micro-, meso and macro fauna, soil pH, soil organic matter, electro-conductivity, base saturation, cation exchange capacity, and soil erosion	Spill coverage, hydrocarbons levels, heavy metals, major and trace elements, ma , porosity, friability, erosibility, composition, soils micro-, meso and macro fauna, soil pH, soil organic matter, electro-conductivity, base saturation, cation exchange capacity, and soil erosion	Soil physical, chemical and biological analysis		Bi-Annually	NARL
		Vegetation Clearance	Area cleared, soil erosion loss per hectare per year, Species loss	Area cleared, soil loss per hectare per year, Species loss			Monthly	NARL
		Micro Climate	Land use/cover change	Rainfall, wind, temperature, pressure, evapo-transpiration and solar radiation	Rainfall, wind, temperature, pressure, evapo-transpiration and solar radiation			DOM
4. SOCIETY								
	Settlem-ents	Migration	Number of people, composition; Number of settlements; Size of settlements, type	Number of people, composition; Number of settlements; Size of settlements, type				Community Development Department in the affected Districts
		Labour	Size and composition of labor force, Available employment opportunities	Size and composition of labor force, Available employment opportunities				Department of Labour and Occupational Hygiene

Table 4.4: Valued Ecosystem Components Drivers (*contd*)

ISSUES	VECS	Driver	Parameter to be monitored	Priority indicators /parameters	Type of monitoring	Monitoring location	Frequency	Responsible institutions
4. SOCIETY								
	Food	Food production and Storage	Acreage of land under food production; Food price index, Food availability in the region; Household incomes; Number of food storage facilities; Food production per unit farmland of priority food crops	Acreage of land under food production; Food price index, Food availability in the region; Household incomes, Number of food storage facilities; Food production per unit farmland of priority food crops				MAAIF, DLGs
		Production	Acreage of land under food production; Total food production in the country	Acreage of land under food production; Total food production in the country				MAAIF, DLGs
	Water and Sanitation	Population	Portable water coverage (quantity, type), Distance to nearest safe water source; Latrine coverage; Number of waste disposal facilities (type)	Portable water coverage, Distance to nearest safe water source; Latrine coverage; Number of waste disposal facilities (type)	Water censuses		Quarterly	DWD, MoH, DLGs, Occupational Health Department
			Number of cases due to water borne diseases and morbidity					
	Health	Population	Number of health facilities, size, level, etc; Prevalence of diseases; Mortality rate	Number of health facilities, size, level, etc; Prevalence of diseases; Mortality rate	Observation, Tissue sampling post-mortem		Annually	UWA, Dept of Health in the affected districts, Occupational Health Department
		Focus on those directly or indirectly associated by the Occupational hazards	Number of deaths by cause; Occupational diseases, accidents, households	Number of deaths by cause. Occupational diseases, accidents, Main causes of mortality and morbidity				
	Energy	Population	Number of households using energy source by type and quantity, energy demand and supply by type; energy access and status	Number of households using energy source by type and quantity, energy demand and supply by type; status of energy access				Dept of Energy, MEMD, DLGs, Ministry of Trade and Industry
		Industry	Number and type of industries, type and quantity of energy used	Number and type of industries, Type and quantity of energy used and quality				
	Infrastructure	Mineral Development	Quantity and location of mineral resources, available infrastructure (transport, communication, social facilities, industrial) type, length, purpose, coverage	Available infrastructure (transport, communication, social facilities, industrial) type, length, purpose, coverage				Dept of Mineral Development, MEMD
	Education	Population	Coverage (Number of educational facilities; Number of school-going age children), literacy rate	Coverage (Number of educational facilities; Number of school-going age children), literacy rate				Dept of Education in the affected districts

Table 4.4: Valued Ecosystem Components Drivers (*contd*)

ISSUES	VECS	Driver	Parameter to be monitored	Priority indicators /parameters	Type of monitoring	Monitoring location	Frequency	Responsible institutions
4. SOCIETY								
	Culture	Migration	Number of ethnic groups and languages	Number of ethnic groups and languages				GLSD, Dept of Community Development in the affected districts
	Archeolo-gical and Cultural Sites	Infrastructure Development	Number of archeological and cultural sites; Location of archeological and cultural sites	Number of archeological and cultural sites; Location of archeological and cultural sites				MTWH, Dept of Community Development in the affected districts
5.BUSINESS AND MANAGEMENT								
	Tourism	Land take/ Clearance, Infrastructure	Number of species and number of animals; Number of tourist facility	Number of species and number of animals	Tourism surveys		3 years	UWA
		Visual Intrusion	Number of tourists; Feedback from tourists	Number of health facilities, size, level, etc; Prevalence of diseases; Mortality rate	Tourism surveys		3 years	UWA
	Fisheries	Aquatic disturbances	Species richness and distribution	Species richness and distribution	CAS		Quarterly	NaFIRRI/DFR
		Oil Spills and Blow outs	Catch rates (catch per unit of effort), fishing inputs (gears, boats, landing sites), Prices	Catch rates, fishing inputs (gears, boats landing sites), Prices, Total catch per fished area	CAS		Quarterly	NaFIRRI/DFR
	Agriculture	Shifts in Economic activities	Sources and levels of income for households, type, systems	Sources and levels of income for households, type, systems				MAAIF
	Transport	Settlements and Infrastructural development	Traffic volumes, loads , type (air, road, water, railway etc), categories	Traffic volumes, loads , type (air, road, water, railway etc), categories				MoWTC
	Forestry	Traffic volume	Forest cover, timber (volumes, prices), loggers within and surrounding areas of the Albertine Graben, demand and supply for fuel wood	Forest cover, timber (volumes, prices), loggers within and surrounding areas of the Albertine Graben, demand and supply for fuel wood	Field surveys, satellite imagery		10 years	NFA
	Construc-tion Materials	Settlements and Infrastructural development	Timber, sand, stone, bricks, murram, gravel (prices and volumes, quarries), Number and type of structures	Timber, sand, stone, bricks, murram, gravel (prices and volumes, quarries), Number and type of structures				NFA MoWTC

Oil testing in the Albertine Graben.
Source: PEPD 2010

Gravity and Magnetic data aquisition.
Source: **PEPD 2011**

5 DATA COLLECTION AND ANALYSIS

5.1 AQUATIC BIODIVERSITY

5.1.1 Basis for monitoring/justification and indicators

The limnological characteristics of Lake Albert are unique, but data to assist improved understanding of the ecosystem is limited. There is need to obtain current and continuous limnological data to better understand the ecological functioning of the lake during oil exploration and development.

Lake Albert is recognized as an important hotspot, due to its high proportion of endemic fish species. Introduction of alien aquatic organisms via oil exploration equipment could threaten the level of endemism in the lake. An unpolluted aquatic environment is crucial for fish and other aquatic life. Fish requires good water quality which allows maximum penetration of sunlight, favorable temperatures and pH levels, as well as dissolved oxygen and nutrients in appropriate levels. These conditions support primary aquatic production on which fish is dependent.

Currently, the demand for fish is considerably high. As development and production of oil and gas begin, large settlements will be established, bringing with them a further increase in fish demand. Equally, new settlements will increase pollution from households unless adequate disposal facilities are provided. Fish biological data (reproductive status, breeding seasons, spawning and breeding habitat, and size structure of populations, growth rates and migratory behavior) is necessary to inform management on the status of the fisheries to ensure sustainability. This data is currently either inadequate or lacking.

In order to assess the impacts of oil industry developments on fish and its aquatic habitat, it is important to track changes in fish diversity and distribution by monitoring the biological characteristics of fish. The key parameters to be assessed will include; a fish diversity index (abundance and species composition), keystone fish species, condition factor, fecundity, size at first maturity and length frequency distributions of commercial fish species.

As far as fish production is concerned, inshore shallow water areas (such as Butiaba shelf, deltas and spits) are critical habitats. These areas are prime sites for onshore exploration and sensitive to impact on water quality from operational spills or large scale oil spills. These critical habitats will need to be mapped and monitored in terms of habitat quality using benthic macro invertebrates as bio indicators. These biometric indices such as Ephemeroptera-Plecoptera-Trichoptera (EPT) Index, Diversity index and dominancy will be computed.

Sampling Design and data collection

Gill net sampling surveys will be conducted at georeferenced points in both inshore and offshore waters of the three zones of Lake Albert (North-Wanseko to Tonya; Central-Tonya

to Nkondo; and South- Nkindo to Ntoroko) to obtain fish samples from which diversity index (abundance and species composition), dominancy (Keystone fish species), condition factor, fecundity, size at first maturity and length frequency distributions will be recorded. Total number and weight of fish catch will be recorded. Fish samples will be sorted by species and respective numbers and weights recorded. The individual fish weight and total length will be measured to derive size structure of sampled fish populations. Sub-samples will be obtained and individual fishes dissected to examine the gut, fat content and sex in order to establish diet, condition and reproductive potential of the fish populations.

Ponar/Eckman grab will be used to obtain benthic macro invertebrates samples at geo referenced points in both inshore and offshore waters of the three zones of the lake and will be used to assess quality and health of aquatic habitats. The types and their relative numbers will be recorded and used to determine EPT Index, Diversity index and dominancy. Baseline surveys will be undertaken to determine reference points that subsequently will be used as benchmarks for gauging spatial and temporal changes in the chosen indicators in each lake zone. Limnological parameters (DO, P, N, pH, Temp, Conductivity and Chl-a) will be measured at the geo-referenced sites where macro-invertebrates will be taken.

Data analysis

EPT Index will be determined from the number of taxa of observed; Diversity index will be determined using Shannon-Weaver diversity index. Determination of the above parameters over time and space can help to tell the condition of fish and the health of the aquatic environment. The generated geo-referenced data will be used to make distribution maps of the above described parameters on a temporal basis.

Start-up phase (Baseline)

Currently, there are data gaps which need to be filled by a start-up phase (a baseline survey) to establish the status of aquatic habitat and fish resource as a benchmark for subsequent surveys. Two baseline surveys for both fish and macro-invertebrates coupled with key limnological parameters (DO, P, N, pH, Temp, Conductivity and Chl-a) will be conducted, one in the dry season and another in a wet season in the baseline year.

Subsequent phases (Frequency)

After baseline year, quarterly surveys will be conducted for both fish and macro invertebrates as previously described in the sampling design.

Bioaccumulation of heavy metals and organic compounds in fish and sediments (Ecotoxicological Studies)

Bioaccumulation is a process by which the concentration of toxic substances such as heavy metals and organic compounds (e.g. polychlorinated biphenyls, polychlorinated hydrocarbons) accumulate in living organisms more than the surrounding environment, posing a threat to health, life, and to the environment.

The fact that aquatic organisms can accumulate pollutants such as metals and organic compounds from water is well documented. Bioaccumulation measurements refer to studies or methods monitoring the uptake and retention of pollutants like metals or biocides by organisms such as fish.

These studies will focus on the extent of bioaccumulation of organic compounds, including polychlorinated biphenyls, polychlorinated hydrocarbons (PHCs) and heavy metals including Chromium, Copper, Manganese, Nickel, and Lead in fish and sediments.

Some accumulation levels are likely to exceed WHO recommended limits in fish, making it unfit for human consumption. As fish constitute an important link in the food chain, its contamination by toxic metals causes a direct threat, not only to the entire aquatic environment, but also to humans that utilize it as food. Consequently, close monitoring of metal pollution of Lake Albert is a must.

Sampling design and Data collection

Lake Sediments and fish specimens will be quarterly collected using mud grabbers and gill nets respectively at selected sample stations on the lake.

Fish samples will be thoroughly ground to powder. One gram (1g) of each ground sample will be put in a 250ml conical flask and 5ml of concentrated Nitric acid will be added and allowed to stand for 2 hours for the breakdown of fish protein. Then 1ml of 70% Per chloric acid will be added, followed by the addition of 1ml of analar grade conc. Sulphuric acid. The mixture will be swirled gently and heated gently at low to medium heat on a hot plate at 100-105OC.

Start –up phase (Baseline)

Some information on PHCs in water and sediments collected by NaFIRRI is available for Ngasa, Kingfisher and Pelican oil-prospected areas. During the start – up phase, quarterly sampling surveys will be conducted to establish the status of concentration levels of heavy metals, PHCs, and polychlorinated biphenyls in fish and lake sediments in Ngasa, Kingfisher and Pelican oil wells and any other selected sampling sites.

Subsequent phases (Frequency)

In subsequent studies, fish and sediment samples will be collected and analysed quarterly to obtain spatial and temporal patterns of polychlorinated biphenyls, polychlorinated hydrocarbons and heavy metals.

WETLAND ECOSYSTEM

Basis for monitoring

Wetlands are areas of land that are permanently or seasonally flooded with soils that are saturated with water and have plants and animals adapted to them. Wetlands are important ecosystems that are valued for a number of services and functions such as water supply, wastewater purification, flood control, microclimate moderation, nutrient retention and they also provide for livelihoods. The wetlands are very fragile ecosystems that are sensitive to any changes in the environment and therefore their integrity needs to be monitored on a regular basis.

The oil and gas developments are likely to disrupt wetland ecosystem functioning thereby causing changes in size, quality and quantity of the physical and biological environment. The indicators that are set to monitor the changes in wetlands include water quality, vegetation cover, acreage, water flow, plant species richness and composition. The main drivers in environmental changes for wetlands related to oil and gas development include waste disposal, water abstraction, physical presence, noise and vibrations, access and foot print. Below is a brief discussion on how the drivers affect wetlands in the oil and gas development.

Waste disposal

The oil and gas developments are likely to yield waste which could be disposed of into wetlands as they occupy lowlands. There are already precedents of waste dumping into wetlands globally that is why there is need to take precaution through this monitoring plan for environmental changes. Waste disposal has potential negative impacts on wetlands as it leads to changes in water quality, size and biodiversity. Waste that affects wetlands is either liquid or solid in form.

Liquid waste pollutes water in the wetland thereby negatively impacting on aquatic life. The pollutants such as heavy metals bio-accumulate in aquatic life and are transferred through the food chain to impact the primary and secondary consumers whose health is affected.

Solid waste dumping on the other hand takes up space by in-filling and this shrinks the wetland size, reduces the habitat and leads to biodiversity loss. Acreage of wetland cover therefore needs to be monitored. In addition, dumping solid waste converts the wetland from aquatic to terrestrial ecosystem thereby affecting its hydrology. The effects are manifested as poor water quality, habitat loss, biodiversity loss and interference with vertical and horizontal movement of water in the ecosystem. Reduction in acreage of wetlands may lead to flooding as a result of disrupting wetland functioning such as flood control. Acreage change can be monitored using Satellite images of high resolution and then processed to produce maps and other related information.

Water abstraction

The water regime in a wetland ecosystem is important as it is the mainstay of a wetland. Once the water regime is significantly changed, it affects the bio-physical and chemical characteristics of the wetland. The oil and gas developments will require substantial amount of water and some of this will be abstracted from wetlands. The wetlands in the area are likely to be alternative water sources in oils and gas development especially in the settlements that are due to be established. The populations are not known today but are likely to be on the increase over time. Water abstraction could be done in excess to deny the wetland water for ecosystem functioning. The water levels/volume of water in wetlands needs to be assessed and monitored both on the surface and underground.

Physical presence

Physical presence of oil and gas developments can affect wetland as there will be need to clear an area for placement of infrastructure. There is likely that some infrastructure due to oil and gas developments cannot be placed in higher grounds and low lying areas are options. The common example is the infrastructure for waste water treatment due to subsidiary developments resulting from presence of oil and gas industry. These may be growth centres for the settlements of workers or otherwise. The physical presence will affect the wetland ecosystem by either draining or infilling which interferes with the wetland ecosystem in many ways. Physical presence would lead to changes in wetland acreage, vegetation cover, habitat loss, biodiversity loss and water levels.

Noise/vibration

Noise/vibration impacts due to oil and gas development activities are likely to disrupt wetland fauna. The fauna that are sensitive to noise are likely to migrate such as birds and mammals. Such fauna which are likely to be disrupted by noise and vibration due to drilling activities or otherwise need to be regularly monitored through population counts.

Access/foot print

Wetland reclamation for infrastructure development leads to alteration of natural properties of wetlands. Access through wetlands in oil and gas development is likely to be through construction of roads which usually disrupt the flow of water, causes changes in wetland acreage, vegetation change, biodiversity loss, changes in species composition and general fragmentation of the ecosystem. The impact of infrastructure development is diverse and it will affect the habitat causing loss of ecosystem functions mainly water and biodiversity components which need to be monitored using some of the sampling designs already alluded to above.

Sampling Design and data collection

Sampling design and data collection in wetlands will mainly be done on the indicators that have been identified namely; water quality, vegetation cover, acreage, water flow, plant species richness and composition.

Water quality sampling

The parameters to measure water quality include; (DO, Chl-a, P, N pH etc,) conductivity, Temperature, BoD, CoD, TSS and heavy metals. Sampling of these parameters will be in accordance with established sampling design under the mandate of the Directorate of Water resources Management (DWRM).

Vegetation cover and acreage

To determine changes in wetland acreage and vegetation cover, remote sensing techniques will be used. This will involve satellite image acquisition, processing and production of maps which will be analysed to generate changes in wetland acreage and vegetation cover. There will be need for frequent acquisition of satellite imagery over the Albertine Graben to be able to carry out monitoring. Mapping the extent of wetlands will be done at the same time when other floral ecosystems are mapped.

Water level

Water level changes in wetlands will be measured using conventional methods. The data collection will also be done periodically to derive changes depending on impact. Measuring water levels will be done in accordance with the guidelines established under the mandate of DWRM.

Plant species, richness and composition

Plant species, richness and composition will be done using systematic sampling. Data collection will depend on areas that have been impacted upon.

Data analysis

Data analysis for water quality parameters, water level and plant species richness and composition will be done using standard methods. Data analysis for vegetation mapping and acreage will be done in the GIS database using queries.

Start-up phase (Baseline)

Baseline data will be collected for each indicator. There will be need to collaborate with DWRM on water quality and level and with NFA for vegetation cover and acreage changes. WMD will engage more on plant species richness and composition. Other stakeholders in the process will be brought on board as deemed necessary.

Subsequent phases

The frequency of sampling for water quality and water level will be done periodically depending on the frequency determined by DWRM. Acquisition of satellite imagery to analyse changes in wetland vegetation cover and acreage will also depend on the frequency agreed upon by other users of satellite imagery such as NFA. The frequency of sampling for plant species richness and composition will be done depending on the existing programmes.

FISHERIES

Basis for Monitoring /Justification and indicators

The Lake Albert fishery is the third largest in Uganda and it is distinctive in being a multi-species fishery. Shallow water areas are much more productive and critical to fisheries but also limited in extent. Numerous fishing villages are located along the shores of Lake Albert

whose inhabitants directly depend on the lake for subsistence fishing and water for domestic use.

The major factors affecting productivity of fisheries resources are fishing capacity and catch per unit effort. Other important factors include aquatic environmental conditions which may partly be influenced by shoreline /catchment based activities.

As oil and gas development activities become prominent in the Albertine Graben, there is a risk of water pollution in Lake Albert through oil spills or inadequate waste management. There will also be interruptions in fishing schedules due to physical presence of oil and gas exploration operations in the fishing grounds. Furthermore, activities like offshore seismic surveys and drilling will generate noise and vibration which can scare fish and alter spatial fish distribution patterns.

For these reasons, fishing capacity and fish catch rates need to be monitored to assess the likely socio-economic dynamics associated with oil and gas development in Lake Albert.

Fishing Capacity

Fishing capacity is an extent of effort employed to harvest fish from a water body in a particular time. Fishing effort includes all the fishing factors (number of fishermen, number of fish landing sites, number and composition of fishing boats, their mode of propulsion, number and type of fishing gears and the fish species they target and the kind of facilities at the landing sites).

Fishing capacity varies over time depending on the socio- economic dynamics of a fishery.

Sampling design and Data collection

Fishing capacity is monitored by conducting bi-annual frame surveys. Frame surveys involve direct and total enumeration of fishing factors and facilities at landing sites.

Before data collection the following preliminary activities are done;

1. Planning meeting to identify supervisors, enumerators (data recorders) and required inputs;
2. Procurement of inputs, publicity and printing of Frame Survey materials; and
3. Training of trainers of enumerators.

Enumerators record data on all the fishing factors by filling the frame survey forms/ questionnaires with details of numbers and sizes of: fishing crafts and mode of propulsion, gears and targeted fish species and data on facilities available at landing sites.

Completed questionnaires are collected from enumerators and returned to the national supervisor for cleaning and coding. Data from the questionnaires is entered into a central database.

The entered data is analyzed to generate frame survey report outlining observations on key indicators of fishing effort.

Start-up phase (Baseline)

Currently, there is a data gap on the fishing capacity of Lake Albert. A comprehensive frame survey shall be conducted as startup phase to obtain the baseline information on the fishing capacity.

Subsequent phases (Frequency)

Frame surveys on the lake will be conducted bi-annually.

Fish Catch Rates

Fish catch rates are measured by catch per unit of effort to provide information on production and productivity of water bodies. Catch rates can be affected by fishing capacity or aquatic environmental conditions of a water body.

Sampling design and Data collection

The information recorded in the frame survey is used to identify primary and secondary sampling sites, and appropriate sampling strata for the fish Catch Assessment Surveys (CAS). Information relating to the total numbers of sampling units (crafts belonging to each craft-gear category) is used to raise sampled catch rates in CAS estimates of total catches.

Before CAS data collection, the:
a) Enumerators (data recorders) are identified and trained; and
d) Required data collection inputs are identified and procured.

Enumerators record data on sampled landing sites and boats by filling the CAS forms with details of number and size of fishing crafts and mode of propulsion, gears and targeted fish species by number and weight and average price per kilogram estimated.

Completed CAS forms are collected from enumerators and returned to the national supervisor for cleaning and coding. Data from the CAS forms is entered into a central database.

The entered data is analyzed to generate quarterly CAS reports, describing trends and patterns of fish catch rates and fish production estimates.

Start –up phase (Baseline)

Currently, there is a data gap on fish catch rates and estimated fish production on Lake Albert. In the baseline year, CASs will be conducted on selected landing sites to obtain information on the catch per unit effort and production estimates.

Subsequent phases (Frequency)

CASs will be conducted twice in a sampling month per quarter per year.

5.2 TERRESTRIAL BIODIVERSITY

5.2.1 Animals (Mammal, birds, below ground biodiversity)

5.2.1.1 Basis for monitoring

Animals occur in both protected and outside protected areas though most concentrations are found in protected areas. Oil and gas activities may affect animal distribution, numbers, diversity, ranges and breeding patterns. Key drivers of change in animal distribution and behavior that arise from oil and gas activities are described below:

Infrastructure density

Petroleum industry is associated with high Infrastructural development. Infrastructure fragments wildlife habitats and interrupts with migration patterns, thus increasing human-wildlife conflicts, animal stress, in-breeding and other behavioral changes that eventually lead to reduced wildlife productivity. Infrastructure development in sensitive ecosystems also disrupts the feeding and nesting behaviors of avian species. It also directly destroys their habitats and increases mortality. Infrastructure development and human influx affects the feeding and breeding sites of below-ground species. It also directly destroys their habitats and increases mortality.

Traffic volumes
Increase in vehicular traffic often leads to increased wildlife kills and injury which affects animal behavior, ranging patterns and population.

Hazardous waste
Hazardous waste affects mammals especially through food chain. Hazardous waste may arise from contaminated soils due to oil spills and the different chemicals that are used in the drilling and processing of oil and gas.

Poaching
Although poaching is one of the illegal activities taking place in most protected areas, oil activities may lead to its increase. Poaching reduces animal populations and may cause species extinction.

Human influx
With the increase of oil and gas activities in the Albertine Graben, many people are likely to be attracted to the area to get jobs and other associated benefits. Human influx increases human-wildlife conflicts, poaching and illegal trade in wildlife and wildlife products.

Domestic Waste
Domestic waste originates from workers' camps and includes both solid and liquid waste. Domestic waste enhances the risk of human, wildlife, and livestock disease transmission. It also affects animals through their food chains.

5.2.1.2 Sampling design and data collection
Mammal numbers, diversity and range

Data collection within protected areas is carried out periodically (every 3 years) while outside protected areas it is collected according to need. Data collection on mammals can be either by aerial surveys or ground counts. Aerial surveys involve flights along a transect and counts are carried out according to UWA standard methods.

During ground counts, data is collected within plots along a transect. Sampling intervals are determined based on the dominant vegetation type found in the landscape. Distances between plots range from 250 M in closed tropical high forest to 1 Km in open savannah landscapes. Plot size of 40 M radius is often used. Outside protected areas, data is collected along transects at intervals of 1 Km. For mammal ranges, Ranger Based Data Collection (RBDC) will be used to determine ranges of animals. However, for some mammals (e.g. lions, elephants, golden cats), information on their ranges will be collected using radio collars.

Bird numbers, diversity and range
Birds occur in both protected and outside protected areas though most concentrations are in protected areas. Data collection within protected areas is carried out periodically (every 3 years) while outside, it is according to need. Data on birds is collected at the same plots where mammal counts are carried out and along the transects from one point to the other. However, annual bird counts are also done on permanent sample plots established in the country. Bird species occurring in the area and the abundance of each species are recorded.

Below ground biodiversity numbers and species

Below ground biodiversity includes worms, insects etc. Sampling will involve physical observation for those that can easily be seen while for the minute organisms lab analysis will be carried out. Species diversity and numbers (where applicable) will be recorded.

Data on key drivers of change

In order to assess impacts of oil and gas development on animals, data on drivers will be collected.

Infrastructure: location and spatial extent of the various infrastructure facilities.

Vehicles: Counts of vehicles passing specific roads or aeroplanes landing or taking off from a specific airstrip carried out for a specified period.

Number of spill incidences: Spill incidence information obtained from records kept by companies and protected areas management.

Heavy metal levels in the food chain: Data is obtained from animal and plant tissues. For sampling plants, purposeful sampling is carried out at sites where an oil spill may have occurred, at drilling sites or at dumping sites. For animals, random sampling is carried out within a determined range from the oil spill area, drilling site or dumping site, according to their susceptibility. Information obtained will be compared with the standard minimum levels of the different heavy metals.

Number and location of snares, and Poached animals: The current RBDC will be used to determine the number and location of snares as well as the different species poached.

Apprehended poachers: The number of apprehended poachers will be obtained from records of the courts of law.

Number of public awareness meetings: Public awareness among the surrounding communities around Protected Areas (PA) is an ongoing process. Records of these meetings will be extracted from the Protected Area management data. Where they do not exist, a system will be set up to start keeping such records.

Human demography: A bi-annual census will be conducted to determine number, density, distribution, sex and age of the people living on the landscape.

Number of human-wildlife conflicts reported: Incidences of human and animal injuries or death, crop raids and animal poisoning will be recorded to determine the trend.

Infrastructure and human influx: Counts of below-ground species such as earth worms and beetles and their abundance.

Hazardous Waste and Oil Spills: An inventory of animal species, including birds that visit the waste pits will be carried out. Species occurring in the area and the abundance of each species will be recorded. In order to determine the level of waste contamination in the animals, tissue samples will be collected from selected species. Counts of below ground species and their abundance at representative waste disposal or oil spill sites will also be carried out.

Domestic Waste: Number and species of animals, including birds, which visit the waste pits where food remains are deposited will be recorded. Those that may have massively died due to consumption of contaminated food will also be collected. In order to determine the level of waste contamination in the animals, tissue samples will be collected from selected species.

Animal kills: Number and species of animals killed along the road, drowned in the waste pits and those that may have massively died due to consumption of contaminated food will be collected. In order to determine the level of waste contamination in animals, tissue samples will be collected from selected animal species including birds.

Incidences of fire: oil spill is a potential for fire outbreaks. The fire incidences originating from oil spills will be recorded. These will be compared to fire from other sources over the same period. Overall fire incidences over a period will be compared to fire over previous periods.

5.2.3 Data analysis

Animals: To generate the required information, collected data will be analyzed using standard data analysis methodologies e.g. biodiversity indices and total species counts used for species richness. Baseline data will be compared with data obtained during or after a specific activity. In addition to analysis of species variation, analysis of the impacts of the drivers of change on species will also be carried out.

Analysis of drivers of change

Infrastructure: With the availability of spatial layers of infrastructure coverage and the area of the landscape, infrastructural density will be calculated using Geographic Information System (GIS).

Traffic volumes: The total number of vehicles counted after the determined period will be analyzed for an average number of vehicles per day. This will be related to the animal injuries or kills counted within the same period. The results obtained will provide a basis on how responsible institutions will guide the oil companies on the best way to reduce or manage traffic in order to minimize its impact on wildlife.

Number of spill incidences: Spill incidence records obtained from companies and protected area management will be analyzed to generate information on spill occurrence variation over specific periods.

Heavy metal levels in the food chain: Laboratory analysis of tissue samples will be carried out to determine the level of waste contamination in the animals including birds. Information obtained will be compared with the standard minimum levels of the different heavy metals.

Number and location of snares, and poached animals: MIST and other analysis methods will be used for processing the RBDC data to determine the number and location of snares as well as the different species poached over a specific period.

Apprehended poachers: The number of apprehended poachers will be analyzed using standard statistical measures to obtain information on variation in numbers over the determined period.

Number of public awareness meetings: For every area where awareness meetings have taken place, analysis of the impact of these meetings will be carried out.

Human demography: The census data will be analyzed using standard statistical analysis methods to determine population density, distribution and age segments. This will be done in order to assess the impacts of human influx.

Number of human-wildlife conflicts reported: Incidences of human and animal injuries or death, crop raids, property destruction and animal poisoning will be analyzed.

Incidences of fire: Oil related fire incidence data will be analyzed and results compared to fire from other sources over the same period.

Mammals: Data collected in the subsequent phases will be analyzed using standard analysis methods and then compared to the previous data. Changes in areas where petroleum activities have taken place will be compared to those where there have not been any activities in order to establish the actual impact of the activities.

Infrastructure: Any added infrastructural layers over the period since the last data collection will be added to the already existing spatial layers of infrastructure. Infrastructure density analysis will then be calculated using GIS.

Traffic volumes: Roads where counts were made in the previous study will be revisited and vehicles counted. This should be either during the same season or when a similar activity is taking place. Data obtained will be analyzed and compared with the information of the previous survey. For the new roads that have been constructed since the last survey, a few will be selected for traffic volume survey.

Hazardous waste

Number of spill incidences and heavy metal levels in the food chain: Data obtained during this phase will be analyzed using the same standard methods and compared to the previous information.

Poaching

Number and location of snares, and poached animals: Data collected after the earlier survey will be analyzed using MIST and other analysis methods and it will be compared to the results obtained from the earlier survey.

Apprehended poachers: Data collected after the earlier survey will be analyzed and compared to information obtained from results obtained from the previous survey.

Number of public awareness meetings: Current awareness impact levels will be compared to impact levels obtained in the previous survey.
For the rest of the indicators, obtained data in the subsequent surveys will be analyzed and compared to results obtained from the earlier survey analysis.
Relationships between the animals and the drivers will also be explored to identify possible impacts of the drivers on the animals.

Start-up phase

Compilation of existing baseline data on animal distribution, numbers, diversity, ranges, breeding patterns and any other relevant datasets will be done. Identification of data gaps and recommendation of studies/actions to be carried out to fill these gaps will be undertaken. In addition, baseline will be compiled on human population and influx, infrastructure, poaching incidences, hazardous waste,
Monitoring of animal distribution, numbers, diversity, ranges, breeding patterns and drivers of change to assess status and trends will be carried out in the subsequent phases using established monitoring protocols.
Collected data will be stored in databases within responsible institutions and accessed by partner institutions on request.
The data obtained will be analyzed, a report prepared and availed to the public. Reports will be prepared periodically according to the agreed period.

Subsequent phases

For the subsequent phases data collection on the above variables and drivers of change will be done according to the agreed time intervals as reflected in the monitoring matrix. The data will be analyzed using standard analysis methods and then compared to the previous data. Changes in areas where petroleum activities have taken place will be compared to those where there have not been any activities in order to establish the actual impact of the activities.
If negative impacts are observed concerning any of the above variables, measures would be recommended to reverse or stabilize the situation.

Floral Ecosystem Components (e.g. forests, savannas, woodlands, agriculture)

Land Cover Mapping

Basis for monitoring (justification, indicators)

The objective of monitoring flagship floral ecosystem is in the first place to establish a baseline and later detect any changes that may be caused by activities related to oil and gas exploration and production. The indicators that will be monitored are change in area of land cover classes.

Sampling design and data collection

Floral ecosystems will be monitored through remote sensing, by means of land cover mapping using satellite images. Mapping will cover the whole Albertine Graben since all the parts of the Graben are part of the ecosystem. Although wetlands are aquatic ecosystems, their extent will be mapped at this stage along other floral ecosystems. Satellite images will be interpreted to produce a land cover/use map based on the NBS methodology and classification. The land cover map will be ground truth to ensure that the interpreted map is accurate. Ground truthing will be done in those areas where land cover change is suspected to have taken place.

Data Analysis

The land cover map will be overlaid with administrative boundaries and protected areas. Therefore the attribute table of the shape file will have names of the administrative unit

they fall under and whether they are protected or not. For the protected areas, the type of protection will be indicated; namely Central Forest Reserve, Local Forest Reserve, National Park, Wildlife Reserve or Community Conservation Areas.

Area statistics will be produced for each land cover types grouped by the categories of administration and protection.

When the second land cover map is produced after about five years, it will be overlaid with the first one for change analysis. Before overlay, a field identifying the year of the map will be created for each land cover map. After the overlay, the resultant shape file will have two fields showing land cover class of the previous mapping and one of the new mapping. Analysis can therefore be done to determine whether the class of the polygon remained the same or whether it changed into a new one and if so to what class.

Start-up phase

The start-up phase will be focused on producing a land cover map that will serve as baseline for reference as subsequent maps are produced. It will require acquiring satellite imagery of medium resolution for interpretation. In some cases, high resolution may be required to carry out detailed mapping. ERDAS IMAGINE, an image processing software and its licenses will be required.

Subsequent phase

Subsequent phases of mapping will produce maps using similar methodology and classification that will be compared with the baseline to see if any changes have taken place. The tools used in the start-up phase can still be used in this phase. However, satellite imagery will have to be obtained for every mapping phase.

Biomass Monitoring

Basis for monitoring (justification, indicators)

The objective of biomass monitoring is to determine the quantity on flagship elements of the ecosystems including numbers, physical size and distribution of plant species in wetlands, forests, savannas, woodlands and on agricultural farms. This will form a baseline for monitoring the impact of oil activities. The indicators of change to monitor are:

1. Number and coverage of invasive species;
2. Biomass stocking;
3. Plant regeneration; and
4. Plant biodiversity.

Sampling design and data collection

Biomass monitoring will be done using the National Biomass Study methodology. In this methodology, 50 by 50 meter plots are established systematically on a 5x10km grid. A cluster of 3 plots is located at each intersection of the grid. In high priority areas, plots are established at each grid intersection. In medium priority areas, plots are located at every other intersection and in low priority areas; plots are located at every third intersection. Priority depends on the complexity of the floral ecosystem. For example, tropical high forests are high on the priority list while sparse grasslands are low on the list. All the trees in the plot whose diameter at breast height (dbh) is 3 centimeters or more will be measured.

In addition, within the plot, a smaller plot of 5 by 5 meters will be demarcated for more detailed study. The plot will also be measured originating from the Global Positioning System (GPS) point of the plot which is the south western corner of that plot. In this plot, saplings will be counted and recorded and grass species present will be recorded.

All plots are geo-referenced with a GPS for easy identification during subsequent visits.

Data Analysis
Field data will be entered in a computer and volumes of trees will be calculated. The NBS allometric system will be used. Plot data will be extrapolated and results will be presented on per hectare basis. Analysis will also be done on species to determine their numbers, diversity, size, regeneration and distribution.

Start-up phase
The start up phase will involve establishing sample plots and geo-referencing them. Data will be collected to establish baseline biomass stocks, species numbers, diversity, size and distribution.

It will require new mensuration equipment (measuring tools). These include distance tapes, diameter tapes, callipers, range finders, hypsometers, clinometers, GPSs, ranging poles, stationary and others. It will also need a short phase of refresher training as most of the technicians will need orientation in biomass monitoring.

Subsequent phase
The subsequent phase will involve revisiting the plots after a period of 2-3 years and carry out re-measurements. The procedure is quite the same as in the start up phase except that this time no new plots are established. Data collected will be compared with that collected in the start up phase. Comparison will be done at regional level and at plot level.

5.3 PHYSICAL-CHEMICAL ENVIRONMENT

Water Quality (justification, indicators)

Basis for Monitoring
Fresh water of adequate quality is a key factor for socio-economic development. Fresh water resources are essential components of the hydrosphere and an indispensable part of all terrestrial organisms. The water resources of the Albertine Graben consist of the following water bodies; Lake Albert, Lake Edward, Lake George and their river systems. Groundwater exists in both fractured aquifers and regolith overlying bedrock.

Oil and gas development processes have a number of drivers which are likely to lead to atmospheric pollution. Atmospheric pollution has an impact on fresh water resources and their availability. The main drivers that will impact water resources are briefly outlined below.

Drill cuttings may contain heavy metals e.g. lead as well as high concentration of Ba, K, Ca, Cl, etc. which are likely to pollute water bodies if not well disposed of. Poor disposal of industrial and domestic waste also pollutes water resources which is harmful to health.

The area around cuttings pits has been sampled to ensure that heavy metals and other elements do not get into water bodies. Routine water quality monitoring is carried out in areas where effluent is discharged into water bodies. The permit holder carries out daily monitoring for D.O levels and submits the data to DWRM on a quarterly basis.

Sampling design and data collection
Physio-chemical parameters such as heavy metals and organic micro pollutants will be sampled at collection, treatment, effluent discharge and receiving water body.

Operational and effluent monitoring will follow guidelines stipulated in the National Water Quality Strategy.

Data collection will be carried out following conventional water quality guidelines.

Data analysis

Data from monitoring programs will be analysed using conventional water quality analytical methods and stored in the national water quality data base.

Start-up phase (baseline)

It is important to understand the chemical composition of both the drilling muds and drilling cuttings before the parameters to be monitored can be decided. There is need to drill piezometers around waste consolidation areas to monitor infiltration of pollutants into groundwater systems.

Subsequent phases (frequency)

Parameters for municipal waste water, effluent and receiving water body will be monitored on a monthly basis.

DWRM will also carry out compliance monitoring to ensure that the processes are not polluting water bodies.

Water Quantity (justification, indicators)

Basis for Monitoring

During oil production, large volumes of water will be required to maintain pressure in the wells. Oil production is not the only water user in the Graben. In order to avoid water user conflicts, monitoring ground water, rivers and lakes levels as well as river discharge and compliance to permit abstraction conditions will be carried out to ensure sustainable water resources utilisation.

Sampling design and data collection

Surface water stations already exist in each of the sub basins in the Albertine Graben. Water level data is collected by observers from both groundwater and surface water stations on a daily basis. Discharge measurements are also carried out by staff from DWRM on a quarterly basis following guidelines in the water resources data collection manual.

The data from these stations is digitized and stored in the national databases from where it can be retrieved for further analytical purposes.

Data analysis

Analysis of data is carried out using conventional hydrological and hydro-geological techniques.

Start-up phase (baseline)

The Nile Decision support system will be used to estimate the available water and to allocate water to different users. Each user will then be required to install water monitoring instruments and submit data from their stations to DWRM on a quarterly basis.

Subsequent phases (frequency)

Subsequent phases will involve routine monitoring of water levels, water discharge quantities and compliance to EIA and permit conditions.

Hazardous Waste, Domestic Waste and Oil Spills

Oil exploration and production is associated with various types of waste such as hazardous waste, domestic waste and oil spills. If not well treated they can be dangerous to humans, animals and the environment in general.

With regards to oil spills, the objective of this monitoring is aimed at identifying number and quantity of spills, their spatial coverage as well as quantity and type of waste. Data to be collected will be the date, location of the waste using a GPS and estimating the volume of the waste. On hazardous waste, the monitoring will cover location, type and quantity of the waste. Parameters to monitor will include:

1. Location of spill or waste;
2. Quantity;
3. Spatial coverage; and
4. Response time to spill.

Further oil development will lead to urbanization and therefore domestic waste will be a big issue and its proper disposal should be well monitored to avoid negative environmental and health impacts. Monitoring will be done in urban centres and the following will be monitored.

1. Quantity in tons;
2. Collection centres;
3. Waste disposal conveyance facilities (vehicles and containers); and
4. Dumping centres.

Data Analysis

Data Analysis will be based on generated frequency tables of spills, types of wastes and trends. In GIS, proximity analysis will be done to show spatial relationship of wastes and spill with other social infrastructure.

Start-up phase

The start-up phase will involve:

1. Establishing a data collection mechanism wastes on oil spills; and
2. Establishing a database.

Subsequent phase

The Subsequent phase will involve routine collection of data and analysing trends and reporting.

Soil Quality (justification, indicators)

Basis for Monitoring

As part of the oil development activities, vegetation is cleared in order to construct drilling pads, oil refinery, seismic surveys and other infrastructure. This leads to exposure of the soil to erosion and its related impacts. Soils are important components of the ecosystem and act as a major sink for various wastes. It is important that their buffer capacity for various constituents of the waste is not exceeded.

If waste is poorly disposed, it leads to pollution of soils through accumulation of heavy metals, chemical and other compounds to toxic levels. Soils are major sources of plant nutrients, heavy metals and other toxic compounds will be taken up by plants, thus entering the food chain with negative consequences. Furthermore, some elements when taken up by plants in excessive amounts become toxic, resulting in poor plant growth thus affecting the productivity of the ecosystem. Oil spills are known to affect soil permeability, porosity, water infiltration, aerations oil biota, availability of plant nutrients which will significantly affect soil quality hence reducing its productivity. Oil spills also pollute the soil and hence affect basic soil nutrients and soil biota.

Soil monitoring is very important for sustaining soil quality and thus ecosystem sustainability. It involves soil sampling and analysis using internationally recommended methods. Field observations and tests will also be carried out to complement the soils chemical, biological and physical analysis. The results from these activities will enable assessment of the impact of the oil and gas activities on the soils ability to support plant growth and also perform essential ecosystem functions and services. This requires seasonal/annual sampling of soil and analyzing the parameters.

The indicators that will be used for monitoring soil quality include area covered by the spill, magnitude and extent of oil traces, hydrocarbons, heavy metals, major and trace elements, porosity, friability, erosibility, composition, soils micro, meso and macro fauna, soil pH, soil organic matter, electro conductivity, base saturation, cation exchange capacity, and soil erosion.

Monitoring of compliance to EIA conditions in regard to oil spill response strategy is also recommended.

Sampling design and data collection

The sampling design and data collection will follow conventional soil sampling methods. Transects will be used to monitor both the movement of various compounds and all sampling points will be geo-referenced.

Data analysis

Soil analytical data will be analysed using standard methods to determine the impact of oil and gas activities on soils ability to support plant growth and perform essential ecosystem services and functions.

Start-up phase (baseline)

Base line soil quality data (for all parameters to be monitored) will be collected around Oil and gas activities and also proposed waste consolidation areas.

Subsequent phases (frequency)

Inspection of locations where oil spills have occurred must be done to ensure adequate clean-up. Monitoring of compliance to EIA conditions in regard to oil spill response strategy is also recommended.

Air Quality (justification, indicators)

Basis for Monitoring

Oil production and processing use equipment that generate noise, particulate matter and gaseous emissions. These constitute air quality pollutants. If the air quality is not controlled, it can affect both plant and animal life in the polluted area. Air pollution and to some extent water pollution is trans-boundary and will affect areas beyond the area where pollution started. Apart from affecting plant and animal life, it also affects human beings within and outside the source of pollution area.

Sampling design and data collection

Air pollutants are quantified by using both portable and stationary scientific equipment and laboratory analysis.

Data analysis

This involves determining the concentration of the air quality pollutants and comparing them with national and international standards.

Start-up phase (baseline)

It is recommended that air quality is monitored for over 24 hours for at least 30 days and then the averages obtained compared with the acceptable levels. The results should determine concentration exposure as per Time Weighted Average (TWA).

Subsequent phases (frequency)

Routine measurement of ambient noise by portable devices and equipment noise audits can be done as a means of monitoring noise pollution. In addition, standardized noise/vibration measurements must be done for all equipment, where possible, vibration insulators and silencers should be used.

5.4 SOCIETY

Basis for monitoring

Monitoring is the measurement through time that indicates the movement toward the objective or away from it. Monitoring will provide information about the status and trends of society or communities. Monitoring is thus a means of checking on progress as well as a tool for improvement. Without it, there is no way of knowing if our management actions are working and how they should be changed to be more effective.

Discovery and subsequent exploitation and development of petroleum resources will greatly influence the society through:

- Changes in population hence; expansion and new settlements;
- Food in terms of production and storage due to increased demand;
- Water and sanitation;
- Health;
- Energy;
- Infrastructure;
- Education; and
- Culture and archaeology.

Sampling design and data collection

Settlements

Settlements are influenced by changes in population due to migration of people in search of labour or business opportunities. These can be monitored by the use of population census which are done every ten years or as when it is deemed necessary for a specific area or purpose. The data to be collected is number of settlements, population (number, age, gender, employment, education).

Food

Food and Agriculture census is carried out every 10 years covering the entire country. So as to ensure food security, one will have to monitor the demand for food, food production and the area under agriculture.

Water and Sanitation

Due to the increased population, there will be need for more or expanded facilities to meet the increased demand. Therefore, it will be necessary to monitor the following:

1. Portable water coverage;
2. Latrine coverage;
3. Number of waste disposal facilities;
4. Distance to nearest safe water source;

5. Time taken to collect water from nearest water source; and
6. Number of cases due to water borne diseases.

Health

The health facilities and situation in the area will be monitored regularly as to ensure adequacy. The factors that will be monitored will include the following:

1. Number of health facilities (location, size and capacity);
2. Prevalence of diseases;
3. Mortality rate; and
4. Number of deaths by cause.

Infrastructure

The Petroleum Industry will require new infrastructure to enable the exploitation and development of oil and gas among others. It is also expected to trigger off a number of other mineral developments which will in turn need their own infrastructure so as to understand the scope of development and to be in inline with the progress we shall need information on the following:

1. Quantity of mineral resources;
2. Location of mineral resources; and
3. Available infrastructure (roads, pipeline, mines).

Education

This is going to be an active area which will attract many families with school-going members. In order to provide for them, it will be necessary to have adequate knowledge on the education infrastructure. Therefore, the following will be important to study regularly:

1. Number of education facilities (location, size and capacity);
2. Number of school-going age children; and
3. Literacy rate.

Archaeological and cultural sites

It is important to know where these sites are and their significance before they are destroyed or disturbed by the new developments. They could also be important areas for tourism. The following will be important to study:

1. Number of cultural sites (location, size and purpose);
2. Number of ethnic groups and languages;
3. Number of the archaeological sites;
4. Location of archaeological sites; and
5. Available infrastructure.

Start-up phase

Review and document the existing information and methods of data collection in the country by the various institutions. This will assist in the actual data available for the Albertine Graben region. This will also help us to identify data collections centers.

Subsequent phase

Regular monitoring and updating of available data will be done. Standard statistical methods will be used.

5.5 MANAGEMENT AND BUSINESS

5.5.1 Tourism

The Albertine Graben has a high tourism potential as it contains a number of PAs. Uganda's

tourism is nature based with about 80% of tourists coming to look at the wildlife and scenery. Most of the PAs are located within the Albertine Graben and specifically around Lake Albert. This area that contains high biodiversity has been found to contain petroleum potential with most of the wells drilled so far occurring in protected areas.

The discovery of oil in high biodiversity area, which is a prime tourism area in Uganda, poses a challenge on how to balance the two activities. Oil activities may negatively impact on tourism through among others land take that reduces habitat for animals, increase in infrastructure, increase in pollution and visual intrusion. In order to assess the impacts of oil activities on tourism, number of species, number of tourists, tourism revenue and habitat quality will need to be monitored.

Sampling design and data collection

Data on tourist numbers, revenue and lodge occupancy will be compiled from UWA, PA managers and lodge owners. A questionnaire will be designed to assess the impact of oil operations on tour operators' activities. A tourism survey will be carried out to assess the tourist attitudes towards oil activities in protected areas.

Data analysis

Data collected over a specific period will be analyzed to assess variation in tourist numbers, revenue and lodge occupancy. The results will also be compared to values of previous years before oil activities started. The analysis should take into consideration other prevailing conditions that could have affected tourism within that period.

The data obtained from the questionnaire from tour operators and tourists will be analyzed using statistical methods and the results compared with the previous records.

Start – up phase

Existing records at various stakeholders' locations will be compiled to know their status. Where data collected is not sufficient, institutions/operators will be advised on better methods of capture and storage.

Subsequent phase

Data collected at the determined time after the start-up phase will be analyzed and compared with outputs from the start-up phase. Changes in levels of tourism related activities where petroleum activities have taken place will be compared to those where there have not been any petroleum activities in order to establish their actual impact.
If there is a negative impact on tourism, measures would be recommended to reverse the situation.

Trade in timber and non-timber forest products

Infrastructure development, population increase and urbanization are likely to increase demand for timber and non timber forest products. Increased extraction of these products can impact on the environmental health of forests in and around the Albertine Graben. It is important therefore to monitor trade in these products. The indicators to be monitored will be:

1. Volume of timber; and
2. Numbers of non-timber products.

Production and trade in forest products is regulated through licenses and permits issued by NFA and District Forestry Services. Data on forest products will be got from district forest offices in the Graben area and NFA Headquarter permit and license records. There is illegal extraction of timber and non-timber forest products in many parts of Uganda. In these areas, there will be need to conduct surveys to verify data collected from official records.

This will be done by monitoring movement of products on selected routes for specified period such as a week.

Data Analysis

Data collected will be analysed to establish type, quantity and source of forest products.

Start-up phase

The start-up phase will involve establishing data sources and data integrity. Districts that are not keeping records on timber and non-timber products will be assisted to record and store such data. The whole methodology of collecting, storing, analysing data and reporting on these products will need to be established and tested.

Subsequent phase

The Subsequent phase will involve collecting similar data and comparing them with previous ones.

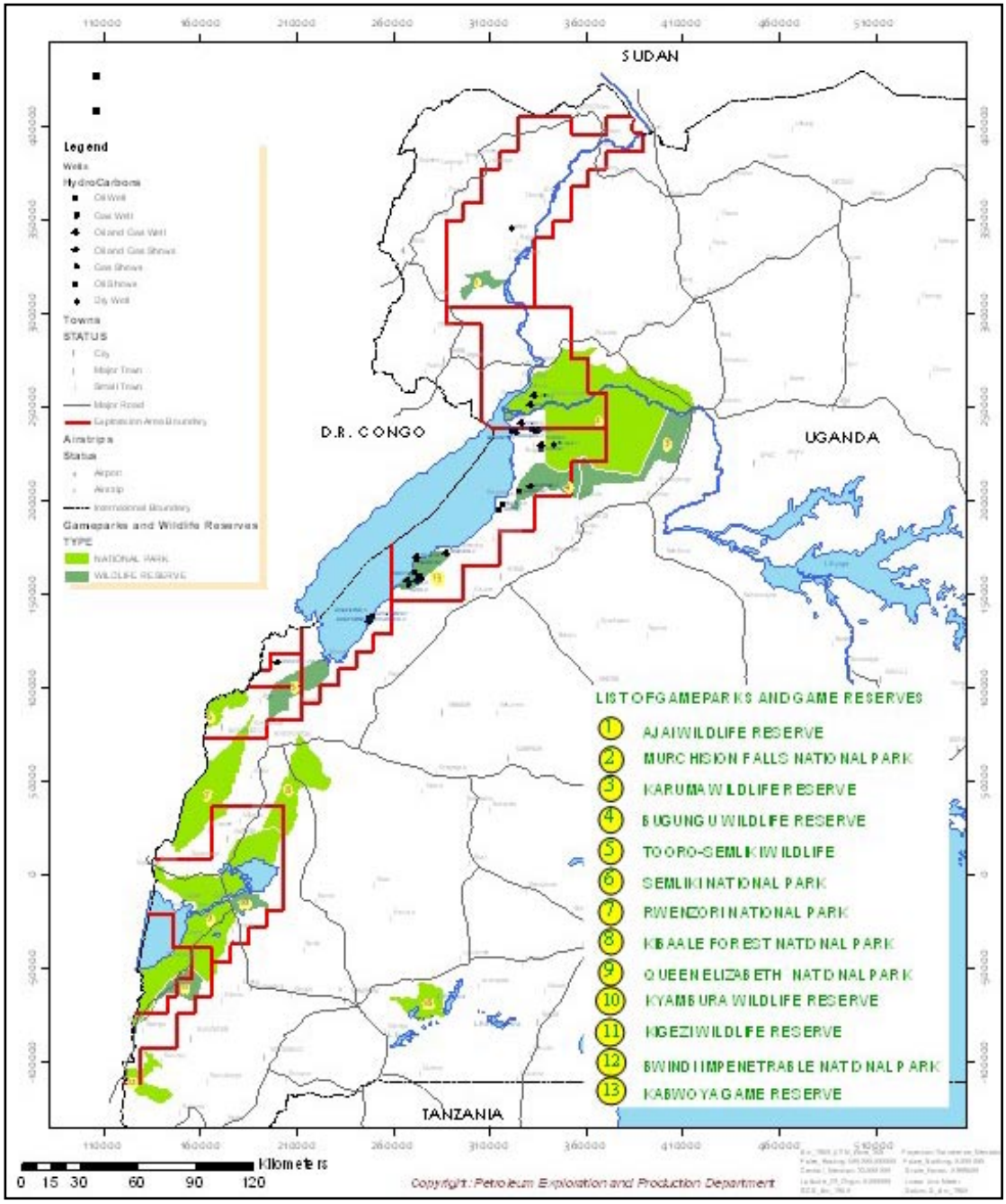


Figure 5: National Parks and Wildlife Reserves in the Albertine Graben
Source: PEPD 2011

6 DATA MANAGEMENT FRAMEWORK

6.1 DATA MANAGEMENT OBJECTIVES FOR THE AG EMP

Using environment information is central to all planning and decision making processes. The collection, analysis, storage and dissemination of reliable information relating to environmental issues are recognized in the National Environment Policy 1994. This was further strengthened in 1995 by the National Environment Act, Cap 153 that put in place the institutional framework that established the National Environment management Authority (NEMA).

Through its mandate, NEMA manages environmental information in the country. Environmental Information Network (EIN) was established in 2001 with the main objective of enhancing the capability of key data producers to exchange and share information in compatible formats at minimal time and cost. All the key data holders are organized in the EIN and the data management framework for the AG EMP will be part of this framework. The implementation of AG EMP will strengthen the collaboration between institutions in information sharing and management.

A key objective of the Albertine Graben Monitoring Program (AG EMP) is to create a publicly accessible, efficient, and transparent platform. This framework will be instrumental in updating and documenting the status of key environmental parameters on a regular basis. The framework provides the need to deliver information using effective and flexible reporting formats to facilitate enhanced decision-making at various levels.

Key stakeholders will be responsible for supporting data management and contributions from their individual monitoring networks and according to their mandate. The AG EMP will focus data management efforts on building mechanisms to access and integrate the data across institutions and networks as well as promoting a common, standardized data management approach at a national level.

It is identified as a need within the EIN to address ownership of data properly. Proper management will increase quality of data, for example, the Environmental Sensitivity Atlas 3rd edition, and will also enable using the same data source and data sets in environmental assessments, management, monitoring, research and other data needs. Data sources, formats, and subjects vary widely across the research and monitoring community. The currently available data published in the Environmental Sensitivity Atlas 2nd edition keeps a significant difference in detail, quality, accuracy, coverage, authors, documentation and legal status.

One challenge is to access, aggregate and publish biodiversity data from the contributors involved in this monitoring plan. Furthermore, it is critical to deliver this information and knowledge using effective and flexible reporting formats to facilitate decision making at various scales (local to national). Meeting these challenges will significantly improve policy and

management decisions through better understanding and timely access to current, accurate, and integrated information on biodiversity trends and their underlying causes. Data distribution could still be hindered by the lack of infrastructure, software, hardware or knowledge on how to use the data. There is need for competence raising and investments in infrastructure to be able to implement the monitoring plan, both in the stakeholder institutions and at NEMA.

The task of aggregating, managing and integrating data from different stakeholders is an arduous task, but the ambition in this plan, is to be able to publish readily accessible information via a web-based data portal. The Arctic Marine Biodiversity Monitoring plan, a data portal system exemplified with this link to a portal on terrestrial system www.cbmp.is could serve as an example.

A common web-based portal will act as a joint entry point for at the Environmental data clearinghouse at NEMA. A secretariat function and a dedicated Data Manager should be established to coordinate the harvesting of meta-data and serve as a focal point for policy and decision makers, scientists and the interested public and in long run support, the development of common database structures. It is important to emphasize that each organization or data custodian maintains their own specialist data in their local databases. For future management of data, the ambition should be development of a web-based distributed system.

Step 1: There should be delivered products and copies of aggregated data and dataset on a regular basis to the EIN Data Clearing House.

Step 2: there should be developed direct access to many decentralized and distributed databases. The development of distributed databases may need both infrastructure and competence investments at the stakeholder institutions. Development of such distributed system will necessitate the adoption and use of standard storage and query protocols, good metadata and web servers (spatial and tabular).

The common denominator will be spatial geo-referencing, with conversion of the data into GIS databases. Spatial resolution will enable a wide range of complex levels of geographical and thematic overlay and integration for trend analyses and the research of the root causes of the loss in biodiversity.

Timelines for implementing this data management approach can be found in Chapter 8. An overview of existing databases, storage and future responsible institutions for management of collected data can be found in the Appendix.4.

6.2 PURPOSE OF DATA MANAGEMENT

Effective and efficient data management is fundamental to the success of the AG EMP. A key measure of success will be the ability to effectively connect individual partners, networks, and indicator-development efforts. This coordinated data-management effort facilitates data access and effectively communicates biodiversity status and trends to a wide range of audiences and stakeholders. If executed correctly, data management can fulfill the following functions:

i) *Quality assurance:* ensures that the source data sets and indicator development methodologies are optimal and that data integrity is maintained throughout processing;
ii) *Consistency across parameters and networks:* encourages the use of common standards and consistent reference frames and base data sets;
iii) *Efficiency:* reduces duplicate efforts by sharing data, methodologies, analysis, and experience;

iv) *Sustainability:* ensures archiving capability and on-going indicator production; and
v) *Enhanced credibility:* provides transparency with respect to methodologies, data sets, and processes.

Implementation of the AG EMP relies on participation from various institutions. An efficient and user-friendly metadata and data management system will facilitate this collaboration. It will offer unique opportunities for monitoring institutions to exchange data, draw comparisons between data sets, and correlate biodiversity data using a common web-based platform. There should be a more specific roadmap developed for data management to guide the management and access of metadata and data amongst AG EMP networks.

6.3 INFORMATION TECHNOLOGY INFRASTRUCTURE FOR DATA MANAGEMENT

The Environmental data clearinghouse and a web-based portal

Monitoring involves a multitude of stakeholders producing information in diverse formats with minimal integration. While much information is produced by these networks, much of it is inaccessible, not reported, or in user-unfriendly formats. New, web-based data management tools and new computational techniques provide an opportunity for innovative approaches to data management.

The EIN network resolved to develop an Environmental Data Clearing-House, situated at NEMA. This mechanism for environmental data will be useful for the AG EMP, as well as other assessment processes within the petroleum industry in Uganda. The clearing house should be the first port of call for information about the environment in Uganda. It should provide prospective data users with enough information to find and possibly also download datasets for use in assessments and analysis. The clearing-house mechanism will rely on EIN guidelines for data sharing. It is suggested to establish a secretariat function to coordinate the harvesting of metadata and products (data sets deemed relevant and publishable). The secretariat should also coordinate funding for revision of relevant data sets according to agreements in the guidelines.

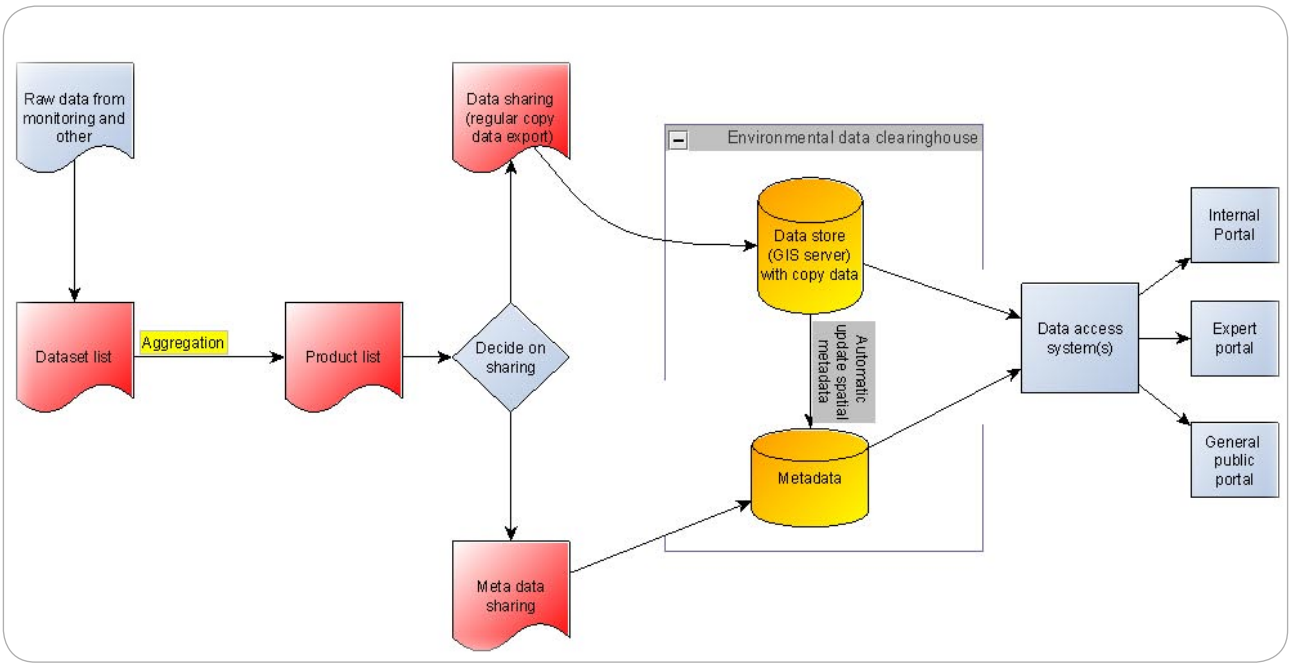


Figure 6: Clearing House Mechanism for environmental data hosted by NEMA, the EIN Data Sharing Focal Point.

A server and ArcGIS server software are already available at NEMA. This software can be set up for publishing data in a web-based portal, however there is also need for metadata handling software. A prerequisite for using ArcGIS is a long term (5 year) solution for license fees. An alternative to ArcGIS could be the open source solution Geoserver.

The AG EMP suggests the development of a simple, web-based and geo-referenced information portal, that access and displays information on a common platform. Geo- Network is an existing open source system initially made by the Food and Agriculture Organization of the United Nations (FAO) which could also fit the bill.

The data portal represents a distributed data management structure where data holders retain ownership, control, and responsibility for their data. As well as providing a focal point for AG biodiversity information, the data portal should provide a simple approach for experts to share information through the web therefore allows integration and analysis of multiple data sets.

A future ambition for the monitoring of Albertine Graben should be the development of a distributed database system, based on a web service and a common database structure for both spatial and tabular queries. Development of this distributed system will necessitate the adoption and use of existing and widely accepted standards for data storage and query protocols, along with high-quality and standardized metadata and web servers (spatial and tabular). Because this requires development of an IT infrastructure within all the stakeholders' institutions, it is suggested as a first step to base the sharing of data on copy data (products, processed, analyzed) to the NEMA clearing house. Existing storage format could be excel or access. A documentation of existing storage and monitoring is enclosed in appendix. When implementing the AG EMP, a lot of new databases need to be established, preferably based on future distributed technology.

Much of the initial work in the implementation phase of the AG EMP will involve aggregating existing data sets to create understandable data layers carried out by the EIN expert groups annually or more frequently if needed. Users (e.g., scientists, decision-makers, and the public) will have controlled access to the data outputs via the AG EMP Data Portal. The life cycle of the data, from collection to presentation, is shown in Figure 7.

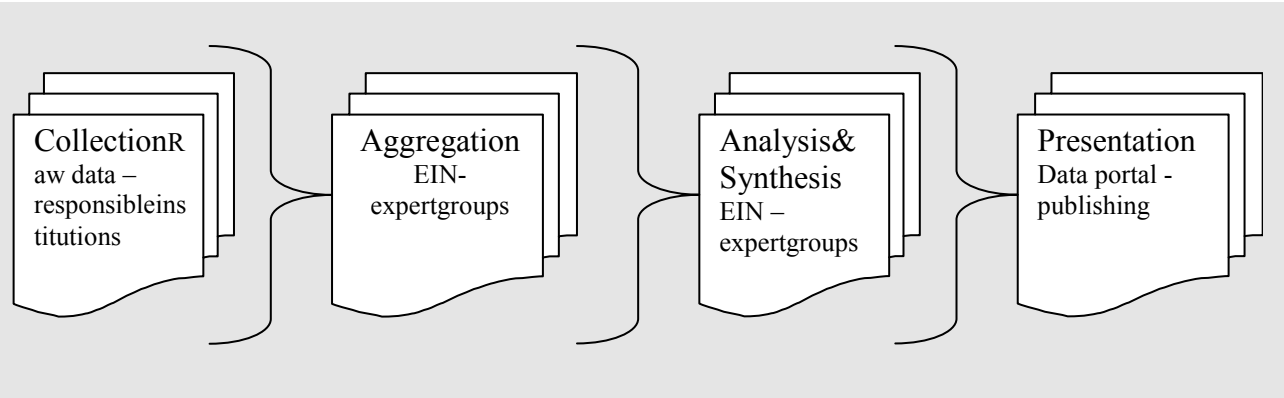


Figure 7: A simplified overview of the steps involved in accessing, integrating, analyzing, and presenting biodiversity information via a web-based data portal.

Geo-referencing to standardize and coordinate systems will be critical to the successful integration of disparate data sets. Techniques will be devised to convert data into a standard format for integration. These technical issues will be addressed during the implementation phase.

Albertine Graben Sensitivity Atlas - Concept Demo

Shows the use of Geoserver and Open Layers combined with Albertine Graben Sensitivity Atlas data

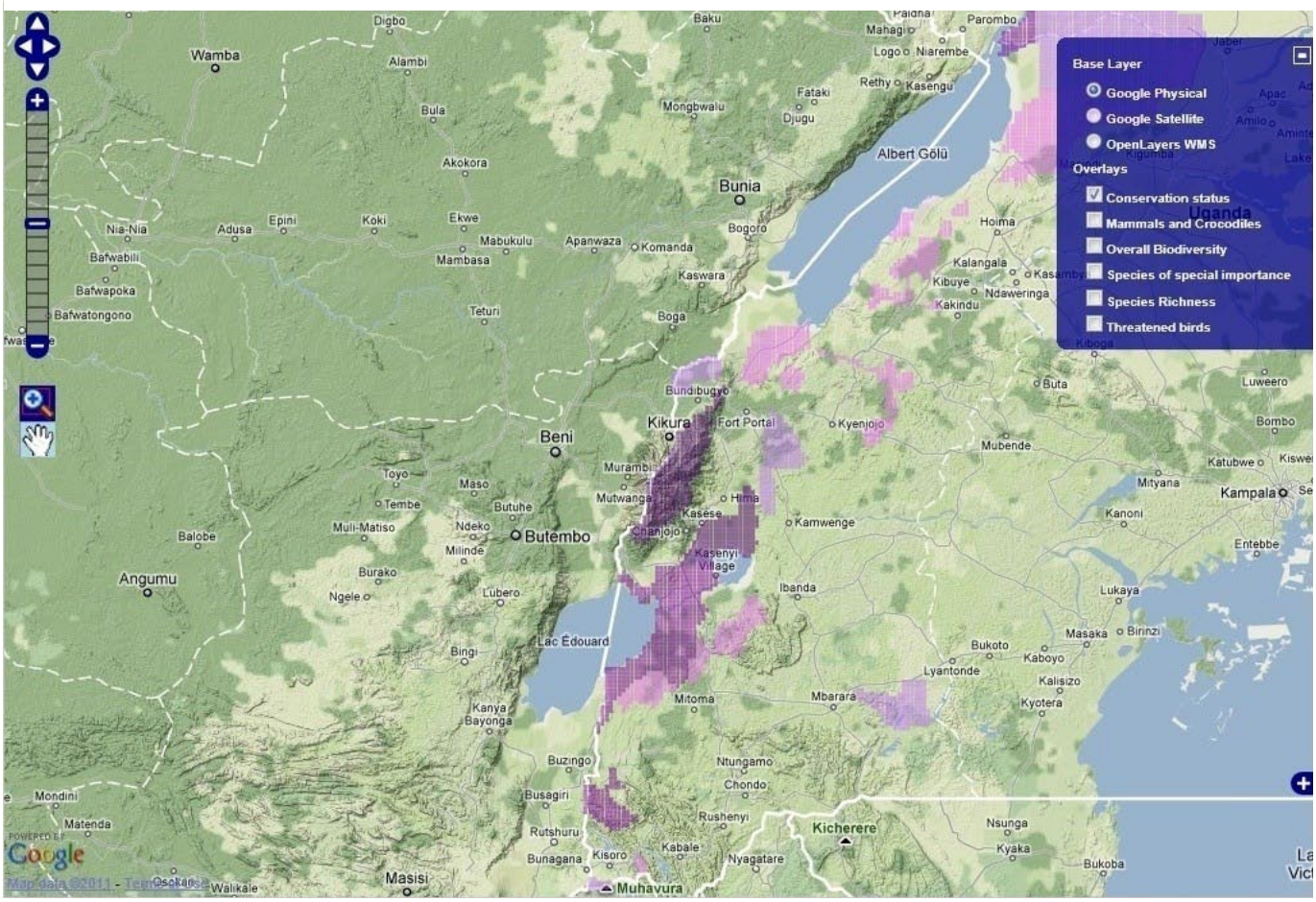


Figure 8: Use of Geoserver and Open layers combined with the Albertine Graben Atlas data.

Web-based portals provide a convenient common entry point allowing for a broad spectrum of users (scientists, decision-makers, and the public) worldwide and controlled access to data outputs. The web-based portal will serve two purposes for the AG EMP. First, it will provide access to geo-referenced information from within partner networks, as well as providing a common platform with multiple entry points for controlled data access, integration, harmonization, and delivery. Secondly, it will enable a wide range of user groups to explore trends, synthesize data, and produce reports with relative ease.

6.4 DATA STORAGE

A decentralized data storage system is proposed for the AG EMP web portal since it offers a solution to concerns over data ownership and copyright.

For all indicators developed under the AG EMP, a database of the time series of reviewed and published indicators should be maintained at the responsible institution. All relevant metadata should be consistently available, along with information about the associated methodology, quality, and interpretation. The AG EMP Meta-Data Archive will be linked to other clearing-house mechanisms for access and dissemination. The specific data sets will be contributed by partners to the monitoring plans as they are developed and published.

6.5 DATA POLICY

6.5.1 Ownership and custodianship

The responsibility for and ownership of the data will always remain with the data collector or holder. At all times, ownership of the data remains with the original collector, who bears responsibility for any changes or amendments to the data.

Data collectors could transfer their rights to a data archive, or maintain their rights and store their data with a data archive or any other data holder who uses their data. It is also possible to release data conditionally (e.g., based on requested input and acknowledgements when data are used). This flexible model embraces all options from free public data to strict data control, and is a feature that will likely prove popular with web portal users and contributors.

6.5.2 EIN - guidelines for sharing of environmental data

A guideline for sharing of environmental data is suggested. The following principles aim at explaining the relations between EIN members with regard to data sharing.

1. The Environmental Information Network (EIN) consists of governmental bodies, NGOs and other stakeholders committed, able and willing to provide environmental data to regional and national level management tasks.
2. The members of EIN all represent ownership of spatial and non-spatial data important for the management of Uganda's Environment. One of the tasks of EIN has been to prepare maps and spatial analysis for official and public use.
3. Products are original data sets, derived data sets – either directly or as a combination from two or more data sets or products.
4. The ownership of products should be agreed upon among the EIN members.
5. All products shall be documented according to an agreed upon subset of properties according to the ISO 19115 standard.
6. All shared data, metadata, and products being free of charge or no more than cost of reproduction within the EIN and for purposes under EIN related projects.
7. A clearing house is established under NEMA. The sharing point makes meta-data available for the general public. Open and restricted products are made available through the focal point. Restricted products are only accessible for EIN members. Members may only distribute their own products.
8. A yearly meeting is held to review the data sharing guideline and to ensure that the EIN members agree upon priorities under the guidelines.
9. The data sharing focal point accepts funding from third parties. Yearly meeting decides on prioritizations.

When gathering primary spatial data the following standards are preferred;

Principles of data sharing and dissemination of data is based on the main principles of the Rio Declaration (Agenda 21, World Summit on Sustainable Development Plan of Implementation (2002), UNGA) on access to environmental information, public participation and access to environmental justice. The Uganda Constitution (Article 41) stipulates that" every citizen has a right of access to information in the possession of the State or any other organ or agency of the State except where the release of the information is likely to prejudice the security or sovereignty of the State or interfere with the right to the privacy of any other person." Article 5 on access to information of 2005 include; promotion of efficient, effective and transparent government, giving effect to Article 41 of the Constitution, protecting disclosing persons, promoting transparency and accountability, empowering the public to scrutinize and participate in government decisions. The Environmental Legislation, National

Environment Act, Cap 153 (NEA) Section 85, stipulates that "every person has freedom of access to any information relating to the implementation of the Act" submitted to NEMA or a lead agency, apply to NEMA or the lead agency and pay prescribed fees in order to access the information. Establishment of a policy for pay/fees for data should be included in EIN guidelines. Legislation should be taken into account to create frameworks for implementation of making environmental information user friendly and accessible.

To be achieved by the guidelines, all AG EMP participants would agree that their data can be utilized, within specified terms, in broader analyses and collections by identified users. All products including value-added products (e.g. GIS layers, reports, analyses) identified and released under the management of NEMA and the AG EMP, will have appropriate acknowledgement secured.

The AG EMP will create a safe and reliable data network, making high-quality digital data available to users online. Restricted data would be flagged accordingly (e.g., in the metadata) and only released for specific usage or by specific users with password access. The technical set-up implemented will allow achievement of this goal and protection to the data holder. Data collectors, holders, and providers will have full freedom to specify the level of detail that they wish to make available.

6.6 DATA RELEASE CODE

All AG EMP participants would agree that their data can be utilized, within specified terms, in broader analyses and collections by identified users within the AG EMP. All products including value-added products (e.g., GIS layers, reports, analyses) identified and released under the management of NEMA and the AG EMP, will have appropriate acknowledgement secured. This can be achieved by the registration of the data user and through a request to sign or agree with basic conditions of use. These protocols should not pose a constraint to free data release to the public.

The AG EMP will create a safe and reliable data network, making high-quality digital data available to global users online. Restricted data would be flagged accordingly (e.g. in the metadata) and only released for specific usage or by specific users with password access. The technical set-up implemented will allow achievement of this goal and protection to the data holder. Data collectors, holders, and providers will have full freedom to specify the level of detail that they wish to make available.

6.7 DATA AND METADATA STANDARDS

In order for the various networks involved in implementing the Monitoring Plan to collaborate, input, and share data and metadata, common data and metadata standards need to be chosen. The EIN has chosen to base their metadata scheme at the ISO 19115 standard for Geographic information.

A revival in the awareness of the importance of geography and how things relate spatially, combined with the advancement of electronic technology, have caused an expansion in the use of digital geographic information and geographic information systems worldwide. Increasingly, individuals from a wide range of disciplines outside of the geographic sciences and information technologies are capable of producing, enhancing, and modifying digital geographic information. As the number, complexity, and diversity of geographic datasets grow, a method for providing an understanding of all aspects of this data grows in importance. Digital geographic data is an attempt to model and describe the real world for use in computer

analysis and graphic display of information. Any description of reality is always an abstraction, always partial, and always just one of many possible "views". This "view" or model of the real world is not an exact duplication; some things are approximated, others are simplified, and some things are ignored. There is seldom perfect complete and correct data. To ensure that data is not misused, the assumptions and limitations affecting the creation of data must be fully documented. Metadata allows a producer to describe a dataset fully so that users can understand the assumptions and limitations and evaluate the dataset's applicability for their intended use (ISO 19115 p 8, 2003). Data that lack metadata are virtually unusable. e.g. Projection standards, ownership, quality descriptions and limitations are important.

There is need to develop a meta-database system (Clearing House - Data Catalogue) to house the metadata, allowing for simple and efficient access to a large and constantly updated, web-based, searchable, geo-referenced data. The chosen indicators identified as core to the implementation of the monitoring plan will be input into this meta-database. It might be necessary to implement a more suitable metadata standard for non-spatial data.

Part of the Oil and Gas Montoring team in the Albertine Graben.
Source: NEMA 2011.

7 REPORTING

This chapter describes the reporting requirements associated with the Albertine Graben Environmental Monitoring Plan (AG EMP). The anticipated schedule for reporting is presented in Chapter 8.

Several levels and reporting formats are anticipated to address the requirements of different audiences. Some reports will focus on the scientific results of the plan, while others will focus on implementation or review. The reporting outputs from the Monitoring Plan will also include regular assessments based on the baselines defined in the Start-up Phase (Chapter 5).

The methods used to report and communicate will vary, depending on the recipient (or target) audience.

7.1 AUDIENCES

Regular reporting will be required to the Government of Uganda, as well as to oil companies active in the area, local community residents, the scientific community (e.g. through peer-reviewed scientific publications), and to other stakeholders and development partners. It is also anticipated that reports and/or communications material will be needed for public audiences, such as non-government organizations and the public.

7.2 TYPES OF REPORTING

Different reporting formats are anticipated, depending on the audience. Table 7.1 below summarizes reporting formats according to audience. Table 7.2 provides anticipated timelines for producing these reports. Different reports will be useful to different categories of audiences.

Table 7.1 Types of reporting by audience

Type of Report Primary Target Audience	State of Albertine Graben Environment Report, including thematic issues status reports	Status of VECs	Independent Review of indicators, parameters, sampling approaches, data management approach, analysis and reporting	Scientific publications	Performance reports and work plans	Various summaries and other communications material
Government of Uganda (Central and Local Government)	*	*	*	*	*	*
Oil companies	*	*		*		*
Local Communities	*	*				*
Science Community	*	*		*		*
Development partners and other stakeholders	*	*		*		*
NGOs and the public	*	*				*

Table 7.2 Timelines for reporting

Type of Reporting	Timing/Frequency
State of Albertine Graben Environment Report, including thematic issues status reports	Every 3 years, starting 2013
Status of VEC's	Every two years, starting 2013
Independent Review of indicators, parameters, sampling approaches, data management approach, analysis and reporting	Every 5 years, starting 2016
Scientific publications	Ongoing
Performance reports and work plans	Annually, starting in 2012
Various summaries and other communications material (Information Education Communication (IEC) materials)	Ongoing, starting 2013

The results that are reported will depend, ultimately, on the focus of the start-up and subsequent phases of the AG EMP.

7.3 REPORTING RESULTS

7.3.1 State of the Albertine Graben Environment Report

The first State of Albertine Graben Environment Report, which could be a revised version of the Environmental Sensitivity Atlas for the Albertine Graben, is targeted for production in 2013 based on the baseline studies in the start-up phase of the AG EMP. It will describe the following:

1) the baseline conditions for Valued Ecosystem Components;
2) temporal changes that have occurred since the baselines were set, in addition to historical trends, where data permits;
3) differences that may have occurred spatially within the area; and
4) recommendations.

The results (e.g. trends, spatial differences, and changes in variability) will be described and interpreted, to the extent possible, both statistically and from a biophysical perspective. Emphasis will be placed on the implications of these changes for the environment. It will be important to discuss the statistical significance, spatial representativeness, and confidence levels of the results.

Subsequent reports are planned every five years, and will include an analysis of how changes of the environment may be linked to the petroleum activities in the plan area.

7.3.2 Status of VECs

The VECs and their indicators used to illustrate the status and trends in the Albertine Graben environment (see Chapter 5) will be updated every two years and published on the Monitoring Program's Data Portal (see Chapter 6). This will allow site users to view changes in the environment between the State of Albertine Graben Environment Reports, and scientific publications.

7.3.3 Independent review

After the first three years a review will be conducted of the parameters, indicators, sampling, data management, and analysis and reporting used in the Albertine Graben Environmental Monitoring Plan (AG EMP).

The AG EMP will be adjusted and updated on the basis of this review and in response to the results obtained about the Albertine Graben environment during the first three years.

7.3.4 Scientific publications

It is anticipated that several types of scientific publications will be produced. It is expected that scientific articles will be published by discipline, as well as along multidisciplinary lines. For the purposes of the AG EMP, the intention is for these publications to address the baseline status and changes to the environment of the plan area. The multidisciplinary publications, especially, are expected to provide insights about changes occurring in the broader environment of the area.

7.3.5 Performance reports and work plans

A requirement of the program, once implementation begins, will be to develop and submit annual performance reports and work plans to NEMA on behalf of the Government for approval. The performance reports will describe progress with implementing and managing the Plan, while the work plans will outline work anticipated for the following year, along with deliverables, budget, etc.

7.3.6 Various summaries and other communications material

A variety of other reporting materials will be developed for non-specialist and non-technical audiences, especially local community residents, and organizations interested in the Albertine Graben environment.

The AG EMP will use the existing multi-media communications network of the Government and related media (e.g. newsletter, press releases, websites, publications, etc.) to provide regular information access/distribution and feedback on program progress and results to the target audiences. This will also enhance the monitoring and evaluation of the AG EMP and related activities.

Signpost to Oil wells in the Albertine Graben.
Source: **NEMA 2011.**

8 ADMINISTRATION AND IMPLEMENTATION OF THE MONITORING PROGRAM

The implementation of this monitoring plan will involve a number of Governmental authorities, research institutes, private companies and business, local communities, etc., which are already engaged in relevant monitoring in the plan area. However, monitoring capacity is limited and will have to be increased to fulfill the plan. The challenge is to develop a simple and cost-effective structure that ensures effective implementation, ongoing data integration, analysis and assessment, and regular review of the monitoring plan. It is also important that the implementation structure allows for a cross-sectorial cooperation.

8.1 GOVERNING STRUCTURE

The governing structure for implementation of the monitoring program involves the Environmental Information Network[1] (EIN) coordinated by NEMA. NEMA will need to establish a monitoring office (secretariat) for the coordination of the Albertine Graben Environmental Monitoring Plan (AG EMP). EIN is composed of representatives from the relevant stakeholders of the plan area. Each representative of EIN will be responsible for ensuring that the monitoring program is implemented within their own sector of relevance, and therefore need to establish close connections or networking with the relevant agencies and experts within their sector. EIN will establish a separate monitoring unit or steering committee to follow up its functions of the program. EIN will also play a key role in providing direction to the evolving monitoring program as a whole. Together with NEMA secretariat, EIN will be responsible for the overall coordination and implementation of the monitoring program.

To facilitate the work of the monitoring plan, the EIN representatives will be responsible for adopting and implementing the plan for their specific Valued Ecosystem Components. This will involve data aggregation, analysis, and management (see Chapters 5 and 6). EIN will review program implementation, produce regular reports, publications and assessments, and adjust the monitoring approach where necessary. Each representative of EIN will work with their respective experts to ensure that the monitoring program is being implemented consistently for their sector and disciplines.

EIN will also be responsible for managing the overall output of the monitoring plan by providing value-added services and integration through the development of and access to data management (web portal and Environment Data Clearinghouse), communications products and reporting (regular assessments) tools and will establish analysis outputs via the Environment Data Clearinghouse (see Chapter 6).

[1]See Appendix 4 for members of the EIN

8.2 PROGRAM REVIEW

A full program review will be conducted every five years to evaluate whether the program is meeting its objectives. This will include a review of the parameters, indicators, sampling approaches, data management, and reporting outputs. Power analysis will be conducted to determine if the sampling approaches are sufficient to detect trends within a specific time frame. The focus of the review will be to determine if the program is meeting its performance objectives (below) and is operating optimally and as cost-effectively as possible. Where deficiencies are encountered, adjustments will be made. If adjustments in the sampling approach or data protocols are needed, it will be important to initiate a period of calibration where the new methods are conducted concurrently with the old methods.

Table 8.1: Performance measures for determining if the Plan's objectives have been met

Objective	Performance Measure(s)
Identify a suite of common parameters and indicators to monitor change in the Albertine Graben environment	Common parameters and indicators in use by 2013 (Phase I)
Identify key a-biotic parameters, relevant to the Albertine Graben environment, that need continual monitoring	Relevant a-biotic monitoring and a-biotic data is being correlated with data showing trends in biota (Phase I)
Identify optimal sampling schemes, making efficient use of existing monitoring capacity	Optimal sampling schemes and coordinated monitoring in place by 2013 (Phase I)
Address priority gaps (elemental, spatial and/or temporal) in coverage	Priority gaps identified and forwarded to EIN (Phase I)
Identify existing datasets and information that can be aggregated to establish baselines and retrospective trends in the Albertine Graben environment	Indicators developed and reported on by 2013 (Phase I)
Provide regular and reliable assessments on key elements of the Albertine Graben environment that respond to reporting requirements	Indicators developed and reported on by 2013. The state of environment report for the Albertine Graben produced in 2013 (Phase I)

8.3 IMPLEMENTATION SCHEDULE AND BUDGET

For an annual average investment of 5-600 000 US$, the AG EMP can greatly increase the value of current monitoring efforts and add new monitoring activities as deemed necessary for an overall, efficient and coordinated environmental monitoring of the possible impacts of the petroleum activities in the area. It is critical that monitoring of core components of this monitoring plan receive sustained funding. The following tables outline the implementation schedule and budget for the AG EMP, focusing on the coordination and integration of the monitoring, data management and reporting.

APPENDIXES

APPENDIX 1: BUDGET FOR THE IMPLEMENTATION OF THE ENVIRONMENTAL MONITORING PLAN

Milestone	Activities & Deliverable	Timeline	Responsible	Administrative & overall costs	Aquatic	Terrestrial	Phys./Chem.	Social	Man. & Bus.	Total cost/US$
1. Plan published	a. Final plan (draft version), work plan and budget 2012 endorsed by Waiswa	Dec 2011	NEMA							-
	b. Plan technically prepared, copy edited and layout	Dec 2011	NEMA	-						-
	c. Printing of final plan	Feb 2011	NEMA	5,500						5,500
										5,500
2. Work plans	Overall annual WP - annual meeting	Oct - Dec	NEMA/EIN	1,000						-
3. Governing structure established and activated	a. Policy approval and kick-off meeting - coord. with SEA	Jan - March								
	b. NEMA monitoring office AG EMP (Secretariat)	Jan - March	NEMA	25,000						25,000
	c. EIN function for the AG EMP (Steering Group - SG)	Jan - March	EIN	10,000						
	d. Norwegian technical support and advise	All year	DN	47,000						82,000
4. Establish coordinated monitoring	**a. Developing monitoring manuals (see issues WP's)**	Jan - March	EIN/Sector		10,000	10,000	10,000	10,000	10,000	50,000
	b. Sector authorities adopt parameters and sampling approaches (see issues WP's)	Apr - June	EIN/Sector		1,000	1,000	1,000	1,000	1,000	5,000
										55,000

APPENDIX 1: BUDGET FOR THE IMPLEMENTATION OF THE ENVIRONMENTAL MONITORING PLAN (*contd*)

Milestone	Activities & Deliverable	Timeline	Responsible	Administrative & overall costs	Aquatic	Terrestrial	Phys./Chem.	Social	Man. & Bus.	Total cost/US$
5. Data management structures established (Clearing House in NEMA and advise to local databases - see separate project and budget)	a. Local databases Data (nodes and hosts, data-entry and data standards established for each sector)	Apr - June	EIN/Sector + DN		1,500	1,500	1,500	1,500	1,500	**7,500** -
6. Data collection	*See issues WP's*	*Apr - June*	*EIN/Sector*		*73,000*	*152,308*	*73,000*	*22,500*	*25,000*	***345,808***
7. Reporting and coordination	a. Annual performance reports and workplans	Oct - Dec	NEMA	1,000						1,000
	b. State of environment report for the Albertine Graben	Oct - Dec	NEMA	10,000						10,000
	c. General communications			10,000						-
	d. Meeting of the EIN SG	When necessary	EIN	28,000						10,000
	d. Sector coordination and information (see issues WP's)	When necessary	*EIN/Sector*		*7,000*	*14,615*	*7,000*	*40,000*	*50,000*	***118,615***
	e. Information at other events	When necessary	NEMA	5,000						1,000
	f. Meeting with oil companies and other stakeholders	When necessary	NEMA	3,000						-
	g. Making an information brochure	Oct - Dec	NEMA	9,000						-
										22,000
8. Program review and adjustment	a. Independent review of parameters, sampling approaches, data mgmt approach, analysis, and reporting (every 5 years)	2015	EIN							
Subtotal adm. & overall 1-8 (except 6 and 7f)										
Subtotal baseline and data collection (6 + 7f)										**464,423**
OVERALL TOTAL										**517,808**

APPENDIX 2: Budget for Data Quality, Management and Dissemination

Data quality, management and dissemination															
		Uganda	Norway												
		Costs 2012	Costs 2012	1	2	3	4	5	6	7	8	9	10	11	12
Administration															
DM_0_1	Travel	$0	$20,000												
DM_0_2	Work	$0	$0												
		$0	$20,000												
Clearing house															
DM_1_1	Clearinghouse requirements meeting/workshop	$1,500													
DM_1_2	Geoserver /open layers training	$6,950													
DM_1_3	Requirements /ToR	$5,000													
DM_1_4	Consider bids	$1,000													
DM_1_5	Metadata architecture	$15,000	$10,000												
DM_1_6	Clearinghouse system development	$28,000													
DM_1_7	Data dissemination preparatory training (workshop)														
DM_1_8	Launching of the Clearinghouse														
DM_1_9	Data hosting	$200													
DM_1_10	Clearinghouse technical revisions														
		$52,650 $	**15,000**												
Data management support															
DM_2_1	EMP Advice on thematic data standards and databases		$10,000												
DM_2_2	SEA Advice on thematic data standards and databases		$2,000												

Data quality, management and dissemination															
		Uganda	Norway												
		Costs 2012	Costs 2012	1	2	3	4	5	6	7	8	9	10	11	12
Data management support															
DM_2_3	SA Advice on thematic data standards and databases		$2,000												
DM_2_4	Bi-annual revision														
DM_2_5	GIS/administration assistant	$7,200													
		$7,200	**$14,000**												
Data management policies															
DM_3_1	Policy for sharing data														
	Legal analysis and preparations (NEMA Lawyer)	$10,000													
	Workshop (MoU update/signing), EIN members	$10,000													
DM_3_2	Experience sharing														
	Visit to Norway	$12,000													
		$32,000	**$0**												
	TOTAL	**$91,850**	**$49,000**												
		kr 551,100	**kr 294,000**												

Sensitivity Atlas															
		Uganda	Norway												
		Costs 2012	Costs 2012	1	2	3	4	5	6	7	8	9	10	11	12
Report															
SA_1_1	Inception and planning meeting with EIN members	$10,000													
SA_1_2	Preparation, analysis and standardization	$18,000													
SA_1_3	Compilation of the atlas														
SA_1_4	Compilation of the data on line in the clearinghouse														
SA_1_5	Review by stakeholders														
SA_1_6	Final copy development														
SA_1_7	Technical and copy editing														
SA_1_8	Graphic layout														
SA_1_9	Printing														
SA_1_10	Publish data on the Clearinghouse website														
SA_1_11	Advertising/adverts	**$28,000**	**$0**												

APPENDIX 4: Existing Databases, Storage and Future Responsible Institutions for Management of Collected Data

	Topic	Data Type	Data Required	Responsible Institution	Contact Person
1	**FISHERIES**	**Frame Survey Data**	• Equipment at all landing sites • Catch Assessment data • Hydro acoustic data • Trawl Surveys data • Gill net surveys data • Fish Marketing Data • Fish production data • Monitoring Control & Surveillance (MCS) data • Fish Export data • Other fisheries data sets on wish list (Not currently documented) Obtained from complete enumeration of fishers and their fishing equipment at all landing sites Collected biannually to determine indicators of fishing effort; and generates the following datasets; • Number of fishers • No. fishing crafts, their mode of propulsion • No. types and sizes of fishing gears and the fish species they target • No. of fish landing sites • Supportive infrastructure and services related to the fisheries sub sector	NaFIRRI / DFR	Dr. Ssekiranda & Bakunda Aventino
		Catch Assessment Survey data	Generated from quarterly sampling surveys from FS sampling frame to determine; • Fish catch rates by gear - Catch per Unit Effort (CPUE) • Indicative fish beach price values • Fish production estimates. (Quarterly, Annual)		
		Hydro acoustic Survey data	Generated from biannual Hydro acoustic assessments to generate the following datasets • Fish biomass • Fish stocks density • Fish species spatial distribution and composition		
		Trawl Surveys data	An alternative method to Hydro acoustic surveys. Collected biannually to obtain • Fish biomass, • Fish species composition and distribution • Fish biology information		
		Gill net surveys data	Collected quarterly to obtain • Fish biology data (total and standard length, gut content, species and sex composition/distribution and age at first maturity		

APPENDIX 4: Existing Databases, Storage and Future Responsible Institutions for Management of Collected Data (*contd*)

	Topic	Data Type	Data Required	Responsible Institution	Contact Person
1	FISHERIES	**Fish Marketing Data**	Generated from issuance of Fish movement permits to fish traders/transporters Required for traceability of fish distribution/marketing and fish safety and quality management Collected daily at all designated and gazetted landing sites to generate information on; • Source and destination of marketed fish • Quantity and value of fish marketed • Fish quality and safety	NaFIRRI / DFR	Dr. Ssekiranda & Bakunda Aventino
		Fish Production Data	Ideally recorded daily from all fishing boats However, logistical and personnel limits it to sampling – days - monthly and raised to Annual total fish production estimates by weight (tonnes) by fish species and beach value in Shs.		
		Fish Export Data	Generated from monthly returns submitted by fish processing plants to DFR and compiled into: • Annual fish export data by weight (Tons) and value (US $) (See Table 2)		
		Monitoring Control & Surveillance (MCS) Data	Compiled from routine MCS patrols throughout the year and compiled as: • No. of confiscated and destroyed illegal fishing gears • No. of culprits successfully prosecuted in courts of law over fishing illegalities • Kg/Tons of contraband (immature) fish destroyed or distributed to public on court order		
		Other fisheries data sets on wish list (Not currently documented)	• Aquaculture (Fish farming) data • Data on Fish breeding/nursery areas • Data on fishing grounds		
2	OTHER LAYERS		• Rivers • Roads • Administrative boundaries • Protected areas • Contours		
3	BIOMASS/NFA	**Biomass** **Land cover**	• Woody biomass Data • Data generated from Landsat imagery • Africover data set of 2000-2001 imagery • Land cover change • Deforestation in THF and Woodlands • Data generated from Landsat imagery • 1990 and 2005 data sets	NFA NFA (National Forestry Authority)	Diisi John Diisi John
4	UBOS		• UNHS, UCA, UPHC, Livestock census, UDHS, UNPS, CSD, ABI		Flavia Naiga Oumo

APPENDIX 4: Existing Databases, Storage and Future Responsible Institutions for Management of Collected Data (*contd*)

	Topic	Data Type	Data Required	Responsible Institution	Contact Person
5	**WATER RESOURCES**		• 70 Surface water stations in Uganda • 30 Groundwater stations • Surface water quantity data collected daily • River discharges are measured at least once a quarter • Water Quality monitoring	DWRM and DWD	Wafula Caroline
6	**WETLANDS**		• Wetland Areas • Wetland biodiversity	Wetlands Management Department	Namakambo Norah
7	**LANDUSE**		• Physical Plans for Urban Areas	Physical Planning Department	
8	**SURVEYS AND MAPPING**		Maps Topographic 1: 2,500 1: 10,000 1: 50,000 1:250,000 Control 1: 2,500 1: 10,000 1: 50,000 1:250,000 Cadastral 1: 2,500 1: 10,000 1: 50,000 Thematic 1: 125,000 1: 500,000	Surveys and Mapping Department	Kitaka John

APPENDIX 5: Sensitivity Atlas Standard Guidelines for Maps

Grid:	UTM Zone 36N
Projection:	UTM
Spheroid:	Clark 1880
Unit of measurement:	Meters
Meridian of Origin:	33^{O}00' East of Greenwich
Latitude of Origin:	Equator
Scale factor of Origin:	0.9996
False Coordinates of Origin:	500,000m Easting 0m Northing
Datum:	ARC 1960
General Layout:	(see map on page 95)

The new frame for clipping all maps is given above and all maps should have the outline of the country also as given.
All maps should be exported as : TIFs 300 dpi
All maps should have the major water bodies, rivers and international boundaries.

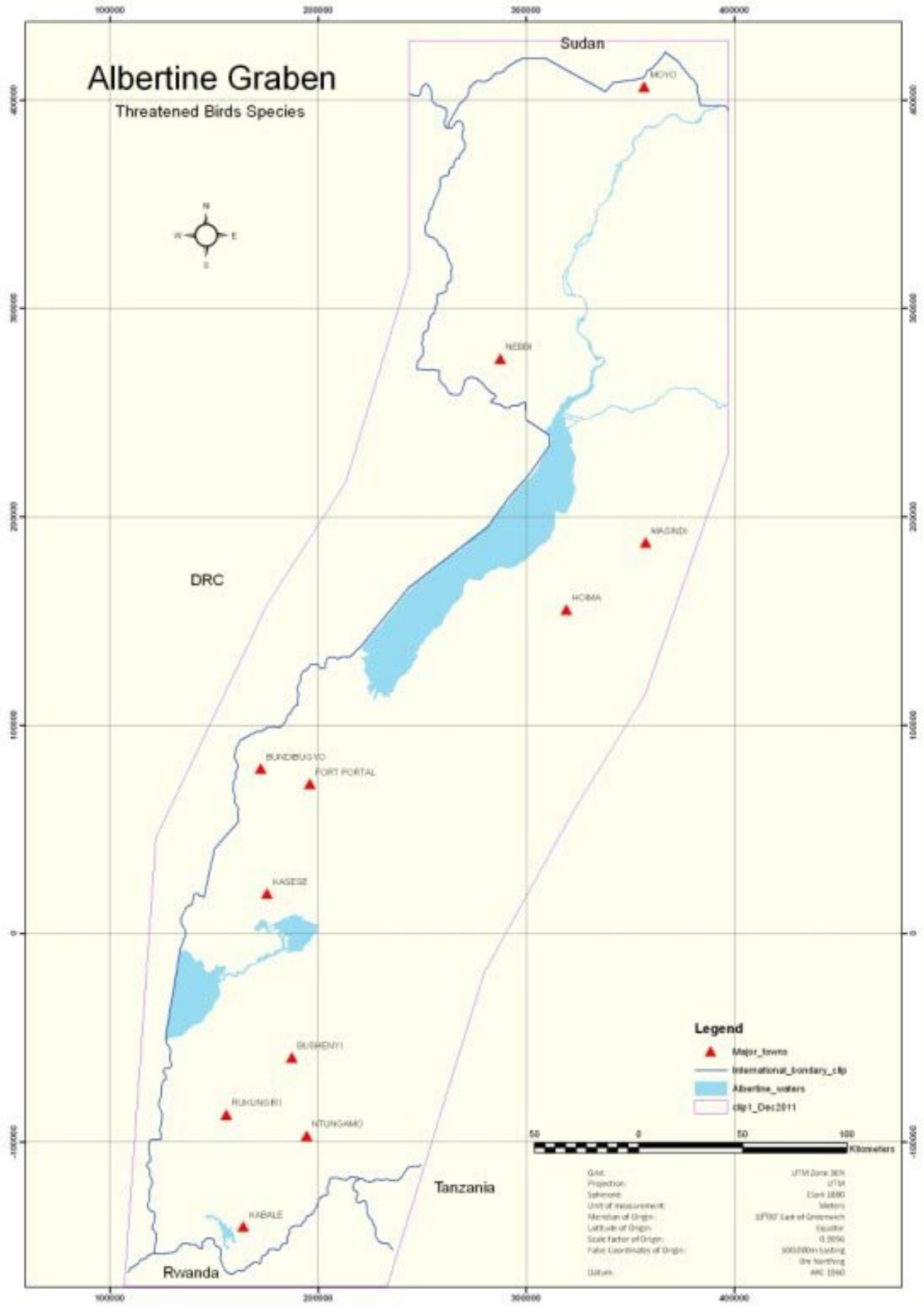


Figure 9: Albertine Graben: Threatened Bird Species.

APPENDIX 6: Metadata Structure

Identification Information (includes data and service identification) s. 48		**O/M**
Name/Title	Name of the dataset	M
Originator	It is recommended that you indicate the party responsible for the data set. While that is most commonly the organization that developed the data set, in some cases, it is not. For example, if a county planning department hires a contractor to build a street centerline road file, the planning department, not the contractor should be identified as the Originator.	M
Publication date	The date that the data was published or otherwise made available. Remember format: DDMMYYYY	M
Online Linkage	As 'repeatable' elements, **Online Linkage** (Citation Information) and **Network_Resource_Address** (6.4.2.2.1.1.1) are used to provide access to a variety of data download, data clearinghouse, and web-mapping services. Use this field to fully represent your geospatial data access and distribution capabilities by providing complete URLs and necessary information to indicate the nature of the web link using the following style guidance: • OGC Web Map Service (WMS) links include a 'get map' request with a layer name, version, preferred image format, and preferred SRS, at a minimum: *http://www.fgdc.gov/metadata/documents/MetadataQuickGuide.pdf April 2006 Vers. 2*; *http://server/service?REQUEST=getmap&VERSION=1.1.0&* LAYERS=roads&FO; RMAT=image/gif&SRS=EPSG:4326	O
Abstract	Brief narrative summary of the content of the resource	M
Status Code list s. 100 – progression code	Status of the resource – code list: completed, historical Archive, obsolete, ongoing, planned, required, underdevelopment	M
Topic (Theme)	Topic Category – code List: farming, biota, boundaries …environment (s. 28). Code List at page 103	M
Point of contact	Contact Info – identification of, and means of communication with, persons and organizations associated with the resources Phone Address Online Resource	M
Keyword	Commonly used words or formalized words used to describe the subject	O
Filename	Name of the file that contains a graphic that provides an illustration of the dataset	M
File Type	Spatial Representation Type Code – vector, grid, text Table, tin ..	M
Geographic Bounding Box	(west bound Longitude, east bound, south bound, north bound)	M
Constraint information (includes legal and security) s. 54		
Use Limitation	the data should not be used at a scale larger than 1:50000 Restrictions for use, and scale limitations	O
Resource format	- ex ArcInfo export – version 9.1 - plotted maps, geodatabase	O
Resource Specific Usage	used to supply government, industry and the general public with an up-to-date status of xxxxx throughout the country	O
Spatial resolution	Mandatory for the raster layers	O
Data quality element information		
Data Quality Information	Completeness Omission Topological Consistency Positional Accuracy Thematic Accuracy Text describing overall	O
Reference System Info		M
Maintenance Information		
Maintenance and update Frequency	frequency with which changes and additions are made to the resource after the initial resource is completed	M
Date of next update	scheduled revision date for resource	O
Content information (includes feature catalogue and coverage descriptions)		
Feature types	Subset of feature types occurring in dataset	M
Attribute description	Description of the attribute described by the measurement value	M
Reference system information		
Projection	Identity of the projection used	M
Distribution information (s. 81)		
Distributor	Provides information about the distributor	M
Distribution format	Provides a description of the format of the data to be distributed	M

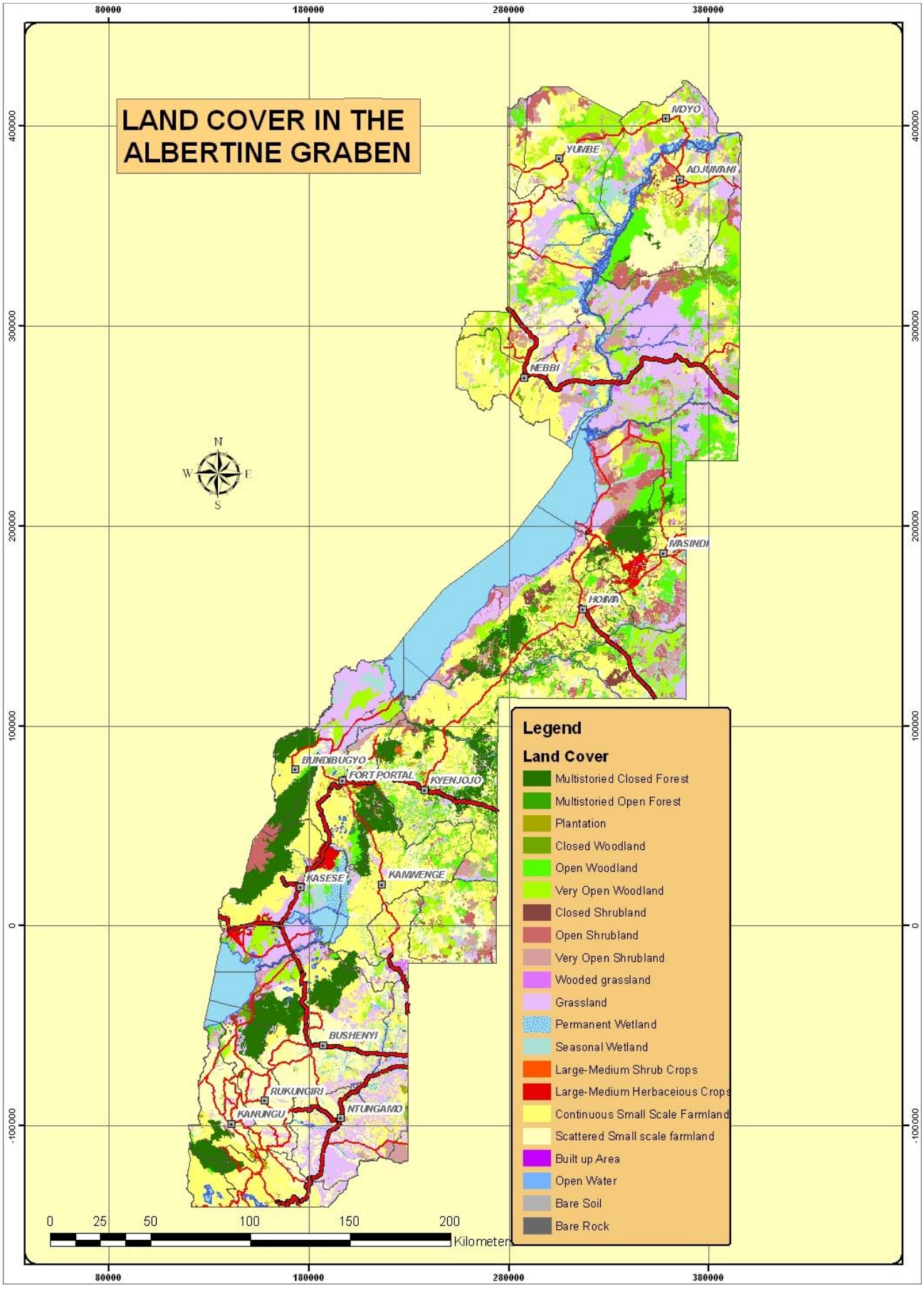


Figure 10: Albertine Graben Landcover (2010).

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